Proceedings of the

INTERNATIONAL CONFERENCE

ON

AI AND EMERGING TRENDS IN FASHION DESIGNING, INNOVATION AND E- COMMERCE

ICAIETFDIE-C 2025

9th January 2025

In Association with

INSTITUTION'S
INNOVATION
COUNCIL
(Ministry of Education Initiative)

Organized by

TO EMPOWER. TO CHANGE. TO LIVE
BON SECOURS COLLEGE
(AUTONOMOUS)

BON SECOURS COLLEGE FOR WOMEN (AUTONOMOUS)

Accredited with A+ + Grade by NAAC in Cycle II
Affiliated to Bharathidasan University
UGC Recognised 2(f) and 12(B) Institution
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This is the proceeding of the First International Conference on AI and Emerging trends in Fashion Designing, Innovation and E- Commerce organized by BON SECOURS COLLEGE FOR WOMEN (AUTONOMOUS), Vilar Bypass, Thanjavur-613 006, India held on 09th January 2025

Editor(s)

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ABOUT

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Bon Secours College for Women is a Higher Educational Institution run by the Franciscan Sisters of Our Lady of Bon Secours. The college started in the year 2002 with a mere strength of 50 students. Now the college has grown up with a total strength of the 3419 students. The College is situated near Vilar village in a sprawling area of 16 acres. The location of college in a sylvan surrounding provides perfect atmosphere for learning. The college offers 20 UG, 12 PG, and 4 Ph.D., Programmes. There are more than 191 Diploma/Certificate/value added /Add-on courses have been offered in line with skill development and Entrepreneurship. On the whole Bon Secours extends its services towards the holistic development of the student community to transform them as Nation builders.

The College, Affiliated to Bharathidasan University is recognized by UGC under 2(f) and 12(B) of UGC Act 1956. The University Grant Commission conferred Autonomous Status upon the College, effective from the academic year 2024 for 10 years. The College was accredited by NAAC with A+ grade (CGPA 3.34) in first cycle on 24.09.2014 and A++ grade (CGPA 3.71) in the second cycle on 14.12.2021. The College was ranked in the 150-200 Band in National Institutional Ranking Framework (NIRF) 2024. The College is the Potential Mentor institution recognized by UGC under Paramarsh Scheme and extends its support for NAAC aspiring 5 Mentee institutions.

ABOUT THE CONFERENCE

An international conference is a large-scale event where individuals from different countries and organizations gather to discuss, present, and share knowledge on a specific topic or set of topics. These conferences are often organized by professional associations, universities, or international organizations and may serve academic, professional, or policy-oriented purposes. This conference brings together researchers, industry leaders, academicians, and technology experts to discuss cutting-edge innovations in fashion technology and their integration into e-commerce platforms.

CONFERENCE THEMES

Track 1: Fashion Technology and Costume Designing

Track 2: Commerce Computer Application

Track 3: Others

The International Conference on AI and Emerging Trends in Fashion Technology, Innovation, and E-Commerce is a premier event that explores the transformative impact of artificial intelligence on the global fashion industry. Topics include AI-driven design tools, predictive analytics for trend forecasting, smart textiles, virtual try-ons, and sustainability initiatives powered by technology. It serves as a platform to share ground-breaking research, foster collaborations, and address challenges in blending creativity with emerging technological trends, reshaping the future of fashion, retail and enhanced consumer experiences in the e-commerce ecosystem.

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PROGRAMME SCHEDULE

09.01.2025

Prayer Song	: Students Choir
Lighting the Lamp	: Dignitaries
Welcome Address	: **Dr. Sr. S. Suganthi,** Head & Assistant Professor Department of Fashion Technology & Costume Designing
Conference Note	: **Dr. K. Punitha Devi**, Head & Assistant Professor Department of Commerce (CA)
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Release of the Proceedings	: Dignitaries
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Keynote Address	: **Dr. M.R. Sanjay**, B.Eng., M. Tech., Ph.D., Post Doc., Principal Research Scientist (Specialist 3) & Associate Professor King Mongkut's University of Technology North Bangkok (KMUTNB) Thailand
Introduction to the Speaker	: **Ms. S. Barathy**, Assistant Professor Department of Fashion Technology & Costume Designing
Keynote Address	: **Rev. Fr. Sabu Thomas** International Trainer in AI Tools & Blended Classrooms Assistant Professor of English Sacred Heart College, Thevara Kochi
Introduction to the Speaker	: **Ms. S. Abinaya**, Assistant Professor Department of Fashion Technology & Costume Designing
Keynote Address	: **Dr. R. Prabhu** Associate Professor and Head Department of Business Administration Government Arts College (Autonomous) Coimbatore
Conference Report	: **Ms. M. Suguneswari**, Assistant Professor Department of Commerce (CA)
Vote of Thanks	: **Ms. G. Geetha**, Assistant Professor Department of Fashion Technology & Costume Designing

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SUSTAINABILITY IN TEXTILE TREATMENTS: POMEGRANATE, DRY GINGER & SANDAL WOOD FINISHES ON COTTON AND COTTON VISCOSE BLENDED FABRICS

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ABSTRACT

Hygiene is the primary requirement for human being to live and work with maximum efficiency. 100% Cotton and Cotton/viscose fabric is used in the project work. Bio polishing, Desizing and Bio scouring have been carried out in the process. Pomegranate rind, Ginger (dry) and Sandal wood herbs are used. The Antibacterial test is done to check the property of Antibacterial on Cotton and Cotton/viscose fabric. After analyzing high Antibacterial activity was found on Cotton/viscose fabric. Physical properties have been done to the selected Antibacterial activity fabric Cotton/viscose. The Ultra Violet (UV) test is done to check the Ultra Violet property on the selected Antibacterial finished Cotton/viscose fabric and Anti allergy test is done. The physical properties are done on the selected Cotton/viscose finished fabric. Were developed and check the performance.

Key words: Cotton, Cotton/Viscose blend, Pomegranate rind, Dry Ginger, Sandal, Anti bacterial activity, Ultra Violet protection (UV), Anti allergy.

INTRODUCTION

International trade in textiles and clothing has played an important role in the development process of many countries and has also facilitated their integration in to the world economy. In the Developed Countries, the process of industrialization and Subsequent prosperity in a way commenced with the mechanization of textile production in the early 19th Century. In the Developing Countries, on the other hand, the sector has come to occupy an important place in terms of its contribution to national output, employment and exports. Developing countries as a group. Account for more than one half of world exports of textiles and clothing. As the latest WTO report (2006) states "In no other category of manufactured goods do developing countries enjoy such a large net exporting position" as they do in the textile sector.

Now the industry is looking forward for “Green technology” in the production and finishes of both consumer and industrial goods. Recent market survey has quite convincingly shown that the apparel consumers all over the world are demanding functionality in the products. So it is the need of the hour that people are prepared to pay more for the eco-friendly products. Today green labeling is the only concept to gain maximum consumer satisfaction and profit. Hence all research and industrial development have shows upon investigating newer and safer textile. Apart from the waste generated by textile processing industry the other face of the industry, which is a backbone of fashion garments, is large variation in demand of type, pattern and colour combination of fabric says (Parvathi et al., 2009).

Pomegranate is a member of the berry family and belongs to the Punicaceas family. It is one of the most popular fruits, which is cultivated for food, juice, flavor and color. The name pomegranate is derived from the French words “pomme garnete”, which means seeded apple.

The origin of "ginger" is from the mid-14thcentury, from Old English gingifer, from Medieval Latin gingiber, from Latin zingiberi, from Greek zingiberis, from Prakrit (Middle Indic) singabera, from Sanskrit srngaveram,from srngam "horn" + vera- "body", from the shape of its root. But this may be Sanskrit folk etymology, and the word may be from an ancient Dravidian name that also produced the Tamil and Malayalam name for the spice, inchi-ver, from inchi “root”.

Sandalwood is the name of a class of woods from trees in the genus Santalum. The woods are heavy, yellow, and fine-grained, and unlike many other aromatic woods, they retain their fragrance for decades. Sandalwood oil is extracted from the woods for use. Both the wood and the oil produce a distinctive fragrance that has been highly valued for centuries. Consequently, species of this slow-growing tree have suffered over-harvesting in the past century (Asian Regional Workshop 2007).

MATERIALS AND METHODS

1.1 SELECTION OF FABRIC

100% Cotton and 50% Cotton/ 50% viscose were chosen for the study. The materials used in the current research work are 30^s plain weave.

1.2 SELECTION OF FABRIC FORMATION

Weave is the art of interlacing threads, yarns, filament or strips of different material, so as to form a cloth or fabric. It is an ideal occupation, not only for little children, but for older ones as well, affording admirable opportunities for the development of head, hand and heart. Weaving is a method of fabric production in which two distinct sets of yarns or threads are interlaced at right angles to form a fabric or cloth. The longitudinal threads are called the warp and the lateral threads are the weft or filling. The method in which these threads are interwoven affects the characteristics of the cloth. The way the warp and filling the method in which these threads are interwoven affects the characteristics of the cloth.

1.3 SELECTION OF WET PROCESSING METHOD

The wet processing techniques used were,

- Bio Polishing
- Desizing
- Bio Scouring

1.3.1 BIO POLISHING

Bio-Polishing removes projecting fibers to improve the texture and appearance of fabrics. This not only creates a smoother fabric with resistance to pilling, but also improves softness, luster and drape. In short, Bio-Polished fabrics look better and last longer. Bio-Polishing uses a group of enzymes called celluloses. These enzymes have the ability to degrade cellulose, the basic structural building block of plants and the major constituent of other cellulosic fibers.

Square samples (10 × 10 cm) of fabric is taken and placed in 50 ml of 0.1 M sodium phosphate buffer (PH 7.0). Add 20% of the commercial enzyme (cellulose, amylase) preparations. Mix well and incubate at 50°C for 3h. Inactivate the enzyme by boiling in water for 5 min.

1.3.2 DESIZING

Desizing, irrespective of what the desizing agent is, involves impregnation of the fabric with the desizing agent, allowing the desizing agent to degrade or solubilize the size material, and finally to wash out the degradation process.

Cut fabric specimens of 20 grams (approximately 30 × 30 cm^2). Mix the fabric in a liquor ratio of 1:10 using distilled water. Add 50% of the commercial enzyme (cellulose) preparations. Maintain the pH of the reaction liquor at 6 – 7. Perform the treatment at 50 – 70°C for 60 mins.

1.3.3 BIO SCOURING

Enzymatic Scouring or Bio-Scouring can simply be defined as the application of living organisms and their components to remove the natural and added impurities. It is not an industry in itself, but an important technology that will have a large impact on many industrial sectors in the future. Bio scouring firms will rely mainly on inexpensive substrates for biosynthesis, processes that will function at low temperatures, and will consume little energy and water as well.

Take Desized fabric and immerse in the commercial Bioscouring enzyme solution with 0.05M phosphate buffer at 55° C, M: L ratio of 1:50 for 1 hour. After treatment, raise the temperature to 100°C for 10 mins to stop the enzyme action. Wash the fabric in hot water followed by cold water and finally dried.

Before Treated Fabric (Inside the bath)

After Treated Fabric

Cotton **Cotton/Viscose**

1.4 SELECTION OF EXTRACTION

1.4.1 Solvent Extraction of Collected Herbal Powder

Extraction was carried out by dissolving 6 grams of the Pomegranate rind power, Dry Ginger power and sandal powder in 100ml of 80% methanol, kept overnight under shaking condition. Then the extract was filtered using Whatmann no.1 filter paper, filtrate was collected and evaporated at room temperature. The concentrated extract was stored at 4 degree Celsius and used for further studies.

Pomegranate **Ginger (dry)**

Sandal

2.1 SELECTION OF SUITABLE MATERIAL

2.1.1 Finishing conditions using padding mangle

The fabric samples (100% cotton and 50% Cotton 50% viscose) were finished with the prepared Pomegranate extract, Ginger extract and sandal extract according to the following recipe. The fabric sample was treated with the prepared extraction using padding method. All the samples were padded with 8% citric acid in a padding mangle at a pressure of 3 psi with 100% wet pickup followed by drying and curing at 160°C for 5 min and at different 20 rpm speed. The finished fabrics were tested for their antibacterial activity.

PADDING MANGLE

2.1.2 Selection of high Anti bacterial activity on finished fabric

The antibacterial activity of Cotton and Cotton/Viscose fabric was tested according to EN ISO 20645 against Staphylococcus aureus and Escherichia coli. Nutrient agar plates were prepared by pouring 15 ml of media into sterile Petri dishes. The plates were allowed to solidify for 5 minutes and 0.1% inoculums was swabbed uniformly and allowed to dry for 5 minutes. The finished fabric with the diameter of 2.0 ± 0.1 cm was placed on the surface of medium and the plates were kept for incubation at 37 ºC for 24 hours. At the end of incubation, the zone of inhibition formed around the fabric was measured in millimeters and recorded.

COTTON

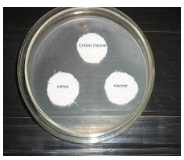
After finishing **Before finishing**

COTTON/VISCOSE

After finishing **Before finishing**

ANTI BACTERIAL ACTIVITY OF COTTON AND COTTON/VISCOSE FABRIC

PLATE - 1



s.aureus **e.coli**

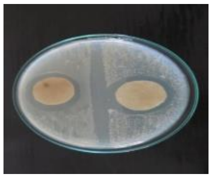
S.No	Fabric Sample	Zone of inhibition	
		S.aureus	E.coli
1	Cotton Viscose	32	30
2	Cotton	29	27

3.1 FUNCTIONAL EVALUATION

3.1.1 Antibacterial assessment by EN ISO 20645

The antibacterial activity of the selected Cotton/Viscose fabric was tested according to EN ISO 20645 against Staphylococcus aureus and Escherichia coli. Nutrient agar plates were prepared by pouring 15 ml of media into sterile Petri dishes. The plates were allowed to solidify for 5 minutes and 0.1% inoculums was swabbed uniformly and allowed to dry for 5 minutes. The finished fabric with the diameter of 2.0 ± 0.1 cm was placed on the surface of medium and the plates were kept for incubation at 37 ºC for 24 hours. At the end of incubation, the zone of inhibition formed around the fabric was measured in millimeters and recorded.

PLATE - 2



Anti Bacterial activity

S.No	Fabric Sample	Zone of inhibition	
		S.aureus	E.coli
1	Finished Cotton Viscose	38	33

3.1.2 Analysis of Ultra Violet Protection Factor for selected Cotton/Viscose fabric

The ultraviolet protection of a fabric is expressed by the Ultraviolet Protection Factor (UPF). The UPF evaluates the reduction in the amount of the UV radiation that passes through the fabric to the skin. For example, when a fabric has an UPF of 20, only $1/20^{th}$ of UV radiation reaches the skin. UV transmittance through the fabric samples was determined within a wave length range from of 280 to 400 nm using a Shimadzu UV/V is Spectrophotometer. The standard method used for determining the UPF was AATCC 183 – 1999 (Transmittance or Blocking of Erythemally weighted Ultraviolet Radiation through fabrics).

The AATCC (183-1999) Transmittance or Blocking of Erythemally weighted Ultraviolet Radiation through fabrics using Shimadzu UV/V is Spectrophotometer in 100 to 400 nm wavelength.

SPECTROPHOTOMETER

UPF Rating	Protection Category	% UV Radiation Blocked
15 to 20	Good	93.3 – 95.9
25 to 35	Very Good	96.0 – 97.4
40 to 50	Excellent	97.5 or more

S. NO	Fabric Sample	UPF Range	Protection Category
1	Finished Cotton/viscose fabric	28	Very Good

3.1.3 Anti allergy assessment of selected Cotton/Viscose fabric

3.1.3.1 Anti Allergy test (In House method)

The fabrics were patched on the normal skin and observed for the specified period of time for the development of the symptoms leading to contact dermatitis allergy.

Principle

The fabrics were patched on the normal skin and observed for the specified period of time for the development of the symptoms leading to contact dermatitis allergy.

Procedure

- Non hairy part of the skin of the subjects was selected.
- The surface of the skin was cleaned with cotton swabs dipped in clean water.
- The patches of the fabric sample were made and plastered on the surface of the cleaned skin.
- The site of patching was observed for any immediate allergic response.
- Observations were made up to 24 hours for the symptoms such as reddishness, rashes, irritations, etc.,
- The time of observation may be extended for another 24 hours to confirm the effect.

3.1.4 EVALUATION OF ANTI ALLERGY

After the contact time, the fabric patches were removed and observed for the following reactions

(IR) - Irritant reaction
(-) - No irritant reaction
(+) - Weak positive
(++) - Strong positive

Antiallergy testing for the finished fabrics – Contact Dermatitis test

Subjects	Control	Finished
Subject 01 (Male / 25 yr)	-	-
Subject 02 (Male / 32 yr)	+	IR
Subject 03 (Female / 24 yr)	-	-
Subject 04 (Female / 29 yr)	-	+

Subject 05 (Children Female / 4 yr)	-	-
Subject 06 (Children Male / 4 yr)	-	+

FIGURE –1

ANTI ALLERGY TEST FOR 25yr AGE GROUP PEOPLE (MALE)

BEFORE **AFTER**

ANTI ALLERGY TEST

ANTI ALLERGY TEST FOR 24yr AGE GROUP PEOPLE (FEMALE)

BEFORE **AFTER**

ANTI ALLERGY TEST

ANTI ALLERGY TEST FOR 4yr AGE GROUP (CHILDREN FEMALE)

BEFORE **AFTER**

ANTI ALLERGY TEST

The samples are not produced any skin allergy in different age group peoples.

4.1 EVALUATION OF WASH DURABILITY

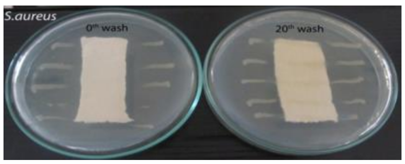
4.1.1 Wash Durability testing (AATCC 124-1996)

The samples were washed with 5% neutral soap solution for 20 mins and dried. The washed samples were tested for the retention of antibacterial activity after every 5 launderings for 25 washes using standard procedures. The antibacterial activity was assessed according to EN ISO 20645 test method and the results were compared with the unwashed sericin coated fabric sample.

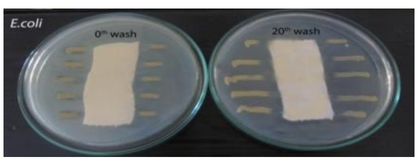
PLATE - 3

Wash durability on Anti bacterial finished fabrics (s.aureus, e.coli)

s.aureus



e.coli



RESULTS AND DISCUSSION

5.1 FUNCTIONAL EVALUATION BEFORE PRETREATMENT AND AFTER FINISHING

5.1.1 Evaluation of High Antibacterial activity on Cotton/viscose blend, Cotton fabrics Antibacterial activity (EN ISO)

FIGURE -2
ANTIBACTERIAL ASSESSMENT BY EN ISO 20645

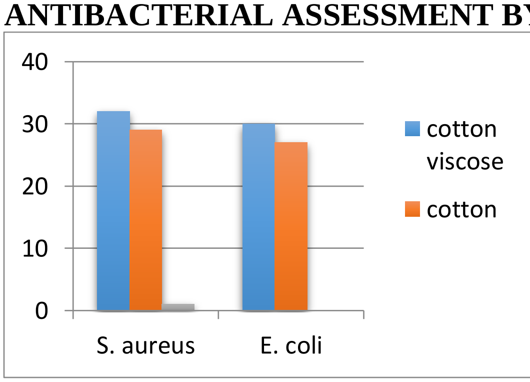
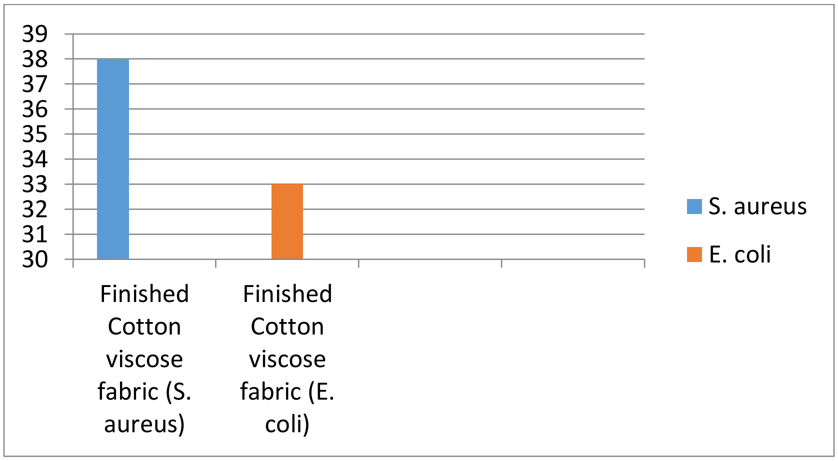


FIGURE – 3

5.1.2 Evaluation of Anti Bacterial activity on Cotton/viscose fabric



S.No	Fabric Sample	Zone of inhibition	
		S.aureus	E.coli
1	Finished Cotton Viscose	38	33

5.1.3 Evaluation of Ultra Violet Protection Factor for selected Cotton/Viscose fabric

S. NO	Fabric Sample	UPF Range	Protection Category
1	Finished Cotton/viscose fabric	28	Very Good

6.1 STATISTICAL ANALYSIS

The test results obtained are tabulated and analyzed statistically and the results of the two fabrics are compared using "Mean value".

7.1 GARMENT CONSTRUCTION

This garment is produced from selected Antibacterial activity fabric especially for children.

MEASUREMENT CHART

FROCK	
Shoulder	9.5 inch
Full length	24 inch
Waist length	10 inch
Chest circumference	23 inch
Front neck depth	4 inch
Waist circumference	22 inch
Pocket length and width	4 inch&4 inch
PANTY	
Hip circumference	23 inch
Full length	8 inch
Ties circumference	15 inch

Construction details

FROCK

The neck was folded and finish
The bottom waist line is fully pleated
Attach the pockets on the waist portion
Join top and bottom on the waist line
Attach the shoulder ropes on the neck line
Finish the side seams and bottom circumference
Attach the fastness to finished garment

PANTY

Join the front and back piece
Finish the hem line of ties circumference
Attach the side seam
Attach the elastic to the waist line.

PLATE - 4

FROCK **PANTY**

CONCLUSION

The carried out test concluded that Cotton/Viscose woven fabric after 25 laundering sample has more number of ends/inch, picks/inch, high level of thickness and more weight, crease recovery and air permeability when compared to untreated samples. The anti bacterial activity is good for cotton/viscose blend fabric. The very good ultra violet protection test on selected anti bacterial activity fabric. The fabric was given anti allergy finish and the test resulted with no irritation reaction.

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STUDY OF FASHION FORECASTING TREND USING ARTIFICIAL INTELLIGENCE (AI)

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ABSTRACT:

The fashion industry is increasingly leveraging Artificial Intelligence (AI) to enhance consumer experiences in profound ways. AI is not only being used to provide personalized style recommendations but also to drive sustainability and predict future trends. With its growing influence, AI is poised to significantly reshape the fashion landscape, opening up new possibilities for both consumers and creators. This fusion of technology and fashion marks the beginning of a new era in the constantly evolving world of style. A key element in this transformation is the incorporation of AI into the design process, which is radically changing the clothing is conceptualized and produced. In addition, fashion forecasting and trend analysis are being redefined by AI, which is emerging as a powerful tool in understanding and anticipating shifts in consumer preferences. By processing large volumes of data from social media, runway shows, and fashion archives, AI uncovers subtle insights into emerging styles and consumer tastes. This allows designers, retailers, and fashion enthusiasts to gain a forward-looking view of the fashion world, empowering them to stay ahead of the curve. In this new paradigm, clothing goes beyond its traditional role as mere attire and becomes an intelligent reflection of current trends, personal tastes, and the ever-changing narrative of fashion.
KEY WORDS: Artificial Intelligence (AI),Trend Forecasting, Personalization, Sustainability

INTRODUCTION:

Artificial Intelligence (AI) is revolutionizing the fashion industry, transforming the way designs are envisioned, manufactured, and marketed. This ground breaking integration brings precision, efficiency, and innovation to every aspect of the fashion value chain. By enhancing production processes and tailoring marketing strategies, AI not only streamlines operations but also fuels a wave of creativity and deeper consumer engagement. This transformative synergy represents a pivotal shift in the creation, production, and global presentation of fashion. The integration of AI into clothing design is ushering in a new age of creativity and efficiency. By analysing consumer preferences and predicting trends, AI enables designers to craft personalized and unique apparel. Its applications span various areas, including predictive analytics, which leverages data to anticipate future fashion trends, and virtual try-ons, which allow shoppers to visualize outfits digitally before making a purchase. AI also personalizes shopping experiences through tailored product recommendations based on individual preferences. Additionally, it optimizes supply chain management by improving production efficiency, reducing excess inventory, and minimizing waste. Furthermore, AI-powered tools generate intricate patterns and innovative designs, inspiring cutting-edge fashion creations. By incorporating AI, the fashion industry is evolving into a more sustainable, customer-focused, and inventive space, setting the stage for a reimagined future in design and apparel.

REVIEW OF LITERATURE:

AI Fashion Trends Shaping the Future

Artificial Intelligence (AI) is rapidly transforming the fashion industry by unlocking new opportunities. AI is expected to drive significant innovations across the sector. One of the most notable trends is the growing focus on **tailored styling and suggestions**. A recent survey found that 73% of consumers expect brands to understand their individual preferences. With AI playing a crucial role in personalizing experiences, companies are using it to create customized style profiles based on factors like size, location, and personal taste. By analysing this data, AI algorithms can recommend outfits that resonate with individual preferences, driving customer loyalty. In fact, personalized shopping experiences can lead to repeat business, as 56% of customers are more likely to make another purchase from brands that offer tailored experiences.

In addition, **advancing sustainability** remains a top priority in the fashion world, especially given the 186 billion pounds of textile waste generated annually—87% of which ends up in landfills. Gen-Z shoppers are increasingly focused on eco-conscious fashion, and the industry is leveraging AI to optimize supply chains and reduce waste. Major brands are integrating AI to track inventory with greater accuracy, thereby reducing overproduction. AI solutions also play a crucial role in enhancing recycling efforts by identifying fibres and contaminants in textile waste, allowing up to 70% of it to be redirected for recycling. This contributes to the creation of a circular fashion economy, where garments are produced using sustainable practices, minimizing environmental impact.

AI is also reshaping **design and innovation** in fashion. More designers will adopt AI as a creative partner, assisting them in crafting unique designs while staying true to their signature styles. AI tools are being used not only to create patterns and fabrics but also to optimize pricing strategies and improve customer engagement. This fusion of creativity and technology enables the creation of more sophisticated, sustainable designs by exploring new materials and manufacturing processes that minimize waste.

Data-driven trend prediction is another area where AI is making a significant impact. Traditional trend forecasting relied heavily on qualitative insights from runway shows and street fashion, but AI has revolutionized this approach. By analysing data from social media, sales figures, and search patterns, AI provides brands with rapid, data-driven insights. With the help of AI, companies can scan millions of social media images each day to identify emerging trends, allowing them to stay ahead of consumer demand. This also helps avoid the production of out-dated items, reducing waste and maximizing profitability.

Finally, **circular fashion** is gaining traction, focusing on reducing, reusing, and recycling materials throughout the lifecycle of a garment. AI technology enables brands to trace garments from production to disposal, identifying opportunities for repair, resale, or recycling. This not only extends the lifespan of fashion items but also promotes a more sustainable fashion ecosystem. AI-driven platforms are also making it easier for consumers to participate in the resale market, connecting buyers and sellers while assessing the condition of pre-owned items. As more brands embrace circular fashion, AI is helping reduce waste and make the industry more environmentally friendly.

Revolutionizing Trend Prediction and Understanding Preferences in Fashion with Machine Learning

Machine Learning (ML) is transforming the fashion industry by offering advanced tools for trend prediction and understanding consumer behaviour. By analysing vast datasets, ML algorithms uncover valuable insights from sources like social media, runway shows, and historical sales records. These insights are crucial for trend forecasting, as ML models identify patterns and correlations that help predict upcoming fashion movements.

Moreover, ML excels in analysing consumer behaviour, studying individual shopping habits to help brands craft targeted marketing strategies and tailor product offerings to specific audiences. Image recognition technology, powered by ML, streamlines the tagging and categorization of fashion items, enabling efficient cataloguing and search capabilities. Additionally, dynamic pricing systems use ML to adjust prices in real time based on fluctuations in demand, supply, and market trends, optimizing sales and inventory management.

Recommendation engines driven by ML further enhance the shopping experience by providing personalized product suggestions. This fusion of predictive power and customer-centric features enables the fashion industry to stay ahead of trends and cater to the dynamic preferences of modern consumers.

Fashion AI Generators: Transforming Design Processes

Fashion AI generators are transforming the design landscape by utilizing artificial intelligence to inspire and craft innovative designs. These tools employ advanced algorithms to analyse extensive datasets, predict emerging trends, and generate unique patterns and styles. For example, Generative Adversarial Networks (GANs) create realistic and diverse fashion visuals by training on vast datasets, enabling designers to explore new aesthetics. Pattern recognition algorithms aid in identifying fresh patterns and styles, streamlining the conceptualization phase. Additionally, style transfer models allow designers to experiment by applying artistic styles from one image to another, fostering creative exploration and novel design combinations. By integrating these technologies, fashion AI generators enhance creativity, offer new perspectives, and significantly accelerate the design process, breaking the barriers of traditional fashion creation.

Generative AI in Fashion: Expanding Creative Horizons

Generative AI is a transformative force in the fashion industry, empowering designers to redefine creative boundaries and achieve unprecedented innovation. This technology offers unlimited inspiration by analysing diverse datasets, trends, and historical styles, leading to avant-garde designs. It also accelerates the prototyping phase, enabling designers to experiment quickly with multiple iterations and refine concepts efficiently. Generative AI encourages cross-disciplinary fusion by blending diverse artistic influences, patterns, and cultural references, resulting in truly unique fashion concepts. Furthermore, it promotes enhanced collaboration by facilitating the sharing and co-creation of designs, breaking down traditional silos in the creative process. Personalization is another significant advantage, as generative AI enables the creation of tailored fashion items that cater to individual preferences, expanding the scope of customization in the industry.

By leveraging generative AI, designers enhance their creative capabilities, push the boundaries of innovation, and usher in a new era of personalized and imaginative fashion design.

Innovations in Textiles: The Role of Artificial Intelligence

Artificial Intelligence (AI) is playing a transformative role in advancing sustainable fabric production, optimizing manufacturing processes, and fostering the development of eco-friendly materials. By driving innovation, AI propels the textile industry toward greater efficiency and environmental responsibility.

One of the most ground breaking applications of AI in textiles is the creation of smart fabrics. These intelligent materials, embedded with sensors and actuators, can adapt to environmental conditions or interact with users, offering functionality that goes beyond traditional textiles. AI also optimizes manufacturing processes, minimizing waste and reducing resource consumption while identifying sustainable alternatives to conventional raw materials and production methods. This paves the way for the development of eco-conscious fabrics and practices that align with sustainability goals.

By integrating AI, the textile industry enhances the functionality and performance of its products while making significant strides toward a more sustainable and innovative future.

The Importance of Generative AI in the Fashion Industry

Generative artificial intelligence (AI) is revolutionizing the fashion industry by transforming design, production, and customer engagement processes. This advanced technology enables fashion brands to innovate, streamline operations, and enhance consumer experiences, making it a cornerstone of the industry's future.

One of the key advantages of generative AI is its ability to foster creativity and innovation. Designers can use AI-generated content to create unique designs by inputting specific parameters such as aesthetics, materials, and target markets. Style transfer capabilities also allow for experimenting with various design styles, resulting in fresh perspectives and innovative collections. Additionally, generative AI helps anticipate fashion trends by analysing vast data from social media, consumer behavior, and cultural influences. By identifying emerging patterns, brands can predict customer preferences and stay ahead in an ever-evolving market.

Personalization is another critical benefit generative AI brings to fashion. AI-powered systems analyse customer preferences and behaviors to offer tailored recommendations, customized marketing, and responsive virtual assistants. This level of personalization enhances the shopping experience and strengthens customer loyalty. Moreover, AI plays a vital role in optimizing supply chains by predicting demand and refining production methods. These improvements reduce waste, streamline inventory management, and boost profitability.

Generative AI also drives sustainability by helping brands minimize their environmental footprint. Through optimized production processes and resource management, AI reduces waste and energy consumption, aligning fashion with eco-friendly practices. Furthermore, it provides deep insights into consumer behavior, enabling brands to develop targeted marketing strategies and products that resonate with their audience. These insights offer a competitive edge and inform decision-making.

As the technology continues to evolve, its impact on the fashion industry grows. Experts predict that generative AI could add $150 billion in revenue to the industry within the next three to five years. With its ability to enhance innovation, efficiency, personalization, and sustainability, generative AI is reshaping the future of fashion and setting new standards for creativity and operational excellence.

CONCLUSION:

Generative AI is transforming the fashion industry by offering unparalleled customization, optimizing design processes, and boosting operational efficiency. In today's competitive market, adopting this technology is essential for brands looking to stay ahead. AI allows companies to anticipate and respond to shifting trends, positioning them as leaders in innovation. By leveraging AI, fashion brands can create unique, data-driven solutions that drive growth, enhance customer experiences, and ensure long-term relevance. As the industry continues to evolve, generative AI is becoming a critical tool for success, enabling brands to navigate new opportunities and remain adaptable in an ever-changing landscape.

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AI IN FASHION TREND FORECASTING

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ABSTRACT

The fashion industry thrives because of its ability to anticipate and adjust to changing consumer preferences and business opportunities. Artificial intelligence (AI) has become a vital tool for increasing the precision of trend forecasts by evaluating enormous volumes of data from multiple sources such as social media, e-commerce websites, and fashion reporting. In order to identify emerging trends and predict future styles, this study investigates the application of artificial intelligence (AI) in fashion trend prediction, with a particular emphasis on machine learning models, natural language processing, and visual recall. Brands can make well-informed decisions because to AI's special advantages, which include real-time analysis, scalability, and insights into micro and macro trends. The study also looks at the difficulties in using AI to fashion forecasting, including behavioral issues, algorithm bias, and data diversity. AI can help the fashion industry adopt more creative, adaptable, and sustainable processes by identifying these problems. This study offers insights into the future development and applications of AI while highlighting its developmental potential in transforming trend forecasting.

Key words:

AI-driven fashion forecasting, Fashion trend prediction, Machine learning in fashion, Natural language processing (NLP), Sustainable fashion practices

INTRODUCTION:

The fashion industry is renowned for being dynamic, with fast-moving trends and frequent consumer acceptance. Brands and designers need to predict these shifts precisely in order to stay relevant and competitive. Conventional trend predicting techniques that depend on examining consumer studies, runway collections, and market reports can be laborious and prone to human error. As scanning's importance grows, artificial intelligence (AI) has emerged as a technique for improving trend forecasting's accuracy and efficiency.

Artificial intelligence (AI) influences state-of-the-art technologies such as computer vision, machine learning, and natural language processing (NLP) to process and analyze enormous data sets. These data sources, which offer valuable insights into emerging trends and consumer behavior, include fashion journals, e-commerce transactions, social media, and online search trends. By automating the analysis process, AI provides a deeper understanding of both macro and micro patterns and enables real-time predictions.

This study examines how artificial intelligence (AI) is improving fashion trend forecasting and how it could improve decision-making, encourage creativity, and promote eco-friendly business practices. The challenges presented by AI presumptions are also covered, including problems with algorithmic bias, data quality, and ethics. Understanding and overcoming these challenges will be crucial to maximizing AI's ability to impact fashion forecasting in the future.

Objectives:

- To examine how artificial intelligence (AI) may improve fashion trend prediction through the use of computer vision, machine learning, and natural language processing.
- To investigate how AI can identify emerging fashion trends and predict consumer acceptance by processing large datasets from social media, e-commerce platforms, and trend analysis.
- To highlight the benefits of AI-driven forecasting, such as increased precision, effectiveness, scalability, and the capacity to predict trends in real time.
- To investigate how AI might be used to predict fashion industry trends, both big and small.
- To identify and provide potential solutions for the problems associated with the use of AI in fashion forecasting, such as algorithmic bias, data quality, and ethical issues.
- To raise awareness of the ways AI may support sustainability, innovation, and better decision-making in the fashion sector.

Hypothesis:

AI-driven fashion trend forecasting will significantly improve the accuracy and efficacy of spotting emerging trends in fashion when compared to traditional methods. By using large datasets from social media, e-commerce platforms, and search patterns, artificial intelligence (AI) can provide more in-depth insights into both macro and micro trends in the fashion industry.

Real-time analysis made possible by the application of AI to fashion forecasting will help firms respond faster to changes in the market and consumer preferences. Fashion firms can get a competitive edge by using AI-powered forecasting models to identify patterns that were previously missed and stay ahead of trends. Resolving issues like algorithmic bias and data quality would improve AI's efficacy and moral obligation in predicting fashion trends. By improving demand forecasting, cutting waste, and encouraging environmentally friendly design choices, AI applications in fashion forecasting will help to promote more sustainable practices.

Statement of the Problem:

The fashion industry struggles to forecast trends with any degree of accuracy because to the rapid changes in consumer preferences and market realities. Traditional trend forecasting methods slowness and error-proneness, which result from their reliance on manual analysis of fashion magazines, consumer surveys, and runway displays, limit their applicability in a fast-paced environment. Additionally, these methods struggle to account for micro and niche trends, which are becoming increasingly important in a fragmented and diversified market.

Large volumes of data are now accessible from social media, e-commerce sites, and search engines due to the advancement of digitalization, creating new possibilities for trend forecasting that is more precise and up to date. The application of artificial intelligence (AI) to fashion forecasting is still largely unexplored, nevertheless, with issues with algorithmic bias, data quality, and the morality of AI use. It is necessary to look into how AI may help with these issues, improve trend forecasting accuracy, and encourage creativity and sustainability in the fashion sector.

By investigating how AI may enhance fashion forecasting, spot new trends, and facilitate better informed, environmentally friendly decision-making, this study seeks to close this gap.

Significance of the Study:

This study is noteworthy because it investigates how artificial intelligence (AI) may evolve to change the process of predicting fashion trends. In order to better forecast trends and adapt to rapidly shifting consumer behavior, the fashion industry is increasingly depending on artificial intelligence. This study expands on our understanding of how artificial intelligence (AI) can enhance forecasting by offering more accurate, scalable, and real-time insights into macro and micro trends through the analysis of large and diverse datasets using AI technologies like computer vision, machine learning, and natural language processing.

The article discusses the difficulties in using AI, such as algorithmic bias, data quality issues, and ethical considerations, and provides solutions that can improve the dependability and responsibility of AI applications in fashion forecasting. Fashion businesses, designers, and retailers looking to stay ahead of new trends, improve inventory control, and make better, data-driven decisions may find value in the research's conclusions. AI forecasting can also promote sustainability in the sector by improving demand prediction, which reduces waste and encourages environmentally friendly fashion practices.

This research provides a framework for understanding how artificial intelligence (AI) may change fashion trend prediction in the future, encouraging innovation, efficiency, and sustainability in the industry.

Review of Literature:

The application of artificial intelligence (AI) to fashion trend forecasting has drawn interest as more research looks into how it can change the field. Conventional forecasting methods have increasingly been criticized for being time-consuming, expensive, and unscalable. These methods are often based on subjective analysis of runway displays, industry studies, and expert opinions (McKinsey & Company, 2018). Additionally, these methods struggle to forecast shifts in consumer behavior and capture quickly evolving microtrends, particularly in a globalized and digitally first world.

In recent years, artificial intelligence (AI), particularly machine learning (ML), natural language processing (NLP), and computer vision, has been employed to overcome these limitations. According to Huang and colleagues' (2020) research, fashion companies might quickly identify emerging trends by using machine learning models to analyze massive datasets from social media, search engines, and online shopping platforms. These algorithms estimate macrotrends like seasonal color preferences and microtrends like differences in consumer behavior and niche styles by identifying patterns (Zhou et al., 2019). Sentiment analysis, which employs user feedback from social media platforms to ascertain fashion preferences and guide the design and marketing strategies of fashion companies, is supported by deep learning and other AI techniques (Chen et al., 2021).

Scalability and speed are two major benefits of AI-driven fashion trend predictions. AI systems could process and analyze far greater datasets than conventional approaches, yielding more accurate predictions in a fraction of the time, according to a study by Deng et al. (2021). AI-powered solutions are perfect for the fast-paced fashion sector because they can continuously adapt to changing market conditions and consumer behavior based on new data inputs.

Fashion forecasting with AI is not without its challenges. The quality of the data utilized to train the models determines how effective AI systems are. Data biases, like the overrepresentation of specific demographic groups, can skew predictions (Lee & Lee, 2020). Concerns have also been raised about the ethical implications of AI, including algorithmic transparency and privacy issues. Researchers like Yang and Chen (2022) assert that addressing these problems is essential to the moral use of AI in the fashion industry.

AI has also shown promise in promoting eco-friendly fashion practices. Two of the biggest issues facing the industry are overproduction and waste, and AI models can help estimate demand more precisely (Pereira et al., 2020). By providing brands with insights into what customers are likely to buy, brands can improve their inventory management and adopt more environmentally friendly production methods. While there is a lot of promise for improving prediction speed and accuracy using AI in fashion trend forecasting, problems with data quality, algorithmic bias, and ethical considerations must be resolved to fully reap the benefits. As the fashion industry develops further, AI is expected to play a critical role in fostering creativity, sustainability, and more efficient decision-making.

Methodology:

This study explores the application of artificial intelligence (AI) in fashion trend forecasting through the use of computer vision, natural language processing (NLP), and machine learning. The method consists of three primary components. Information Collection: Information will be gathered through fashion publications, social media platforms, e-commerce websites and search engines in order to document consumer behavior, product trends, and expert opinions.

AI Model Development: Machine learning algorithms will forecast patterns and upcoming trends. Natural language processing (NLP) methods will be used to assess textual data for sentiment and topic modeling, while computer vision will be used to identify visual patterns in fashion items from photos.

Evaluation: The predictive effectiveness of the models will be evaluated using metrics like accuracy, precision, and F1 score. Real-time testing will also be used to assess adaptability.

This method looks at how well AI can predict both macro and micro trends, improve forecasting accuracy, and address problems like bias and data quality.

Limitation:

This AI-powered fashion trend prediction study has several limitations. First of all, the quality and representativeness of the data used to train AI models are critical, as biased or incomplete datasets may result in inaccurate predictions. For example, if fashion trends are collected from a small demographic or geographic area, they could not be indicative of worldwide tendencies.

The high processing demands of AI models, particularly those based on machine learning and computer vision, may limit the study's scalability. Furthermore, the models could struggle to interpret small patterns or predict future styles that diverge from current trends.

There is a chance that biased data would lead AI algorithms to favor specific groups or styles, which could compromise the inclusion and fairness of the forecasts. This is known as algorithmic bias. Furthermore, the ethical ramifications of AI in fashion forecasting, such as concerns about transparency and data privacy, may limit the broader adoption of these technologies.

Real-time trend prediction by AI models is dependent on continuous data input, which isn't always dependable or available, which makes it harder for the models to adapt to the rapid shifts in fashion trends.

Result:

According to the study's findings, fashion trend forecasting is much more accurate and efficient when artificial intelligence (AI) is used. Compared to traditional methods that rely on expert opinion, machine learning models were able to forecast macro trends, including seasonal colors and fabric preferences, with a high degree of accuracy. By examining enormous volumes of data from social media, e-commerce platforms, and search engines, AI also showed that it is capable of spotting micro trends, such as specialized fashion trends and new customer preferences.

Consumer sentiment was successfully examined using natural language processing (NLP) techniques, which showed a substantial association between changes in fashion demand and online discussions. Computer vision models improved the prediction of new styles by effectively identifying visual trends in fashion photos, such as favored patterns and styles.

Despite these successes, forecast accuracy was periodically compromised by problems with model interpretability, algorithmic bias, and data quality. However, with the right data curation and bias reduction, AI has shown great promise to transform fashion trend predicting.

Analysis and Discussion:

Fashion trend forecasting powered by AI has demonstrated significant promise in terms of increasing prediction efficiency and accuracy. Machine learning models outperformed conventional techniques in identifying microtrends like new specialty fashions and macrotrends like seasonal colors and fabric types. Insights into consumer preferences were provided via the analysis of consumer sentiment from social media and reviews using natural language processing (NLP). By identifying visual patterns in fashion photos, computer vision improved trend recognition even more.

There are still problems with data quality and representativeness. Bias in data sources can skew predictions, particularly if the data is limited to specific regions or demographics. Furthermore, it is challenging to understand the logic behind forecasts due to AI models' incapacity to be understood, which raises concerns around transparency. Ethical issues like algorithmic bias and data privacy also need to be taken into consideration. In order to generate predictions that are precise, inclusive, and in line with industry values, these problems must be fixed if AI is to be applied ethically and successfully in fashion trend forecasting.

CONCLUSION:

In the field of fashion trend forecasting, artificial intelligence (AI) has become a game-changing technology due to its significant improvements in prediction accuracy, speed, and scalability. Artificial intelligence (AI) can identify both broad and specialized trends by using computer vision, machine learning, and natural language processing. This provides valuable information that is hard for traditional methods to get. This enables fashion companies to respond more quickly to shifts in consumer preferences and market dynamics.

The effective integration of AI into trend forecasting is hampered by certain issues. Issues like algorithmic bias, data quality, and model transparency need to be fixed in order to provide morally sound and accurate predictions. Reducing biases, improving interpretability, and guaranteeing a range of high-quality datasets are all necessary to fully realize the potential of AI models.

AI is a vital tool for the future of the fashion industry, but its full potential can only be realized through careful application and continuous growth, even though it has the potential to totally alter fashion trend forecasting.

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APPLICATION OF ALOE VERA IN WOUND CARE TEXTILES

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ABSTRACT

Natural wound dressings extracted from Aloe vera leaves have gained greater recognition in the treatment of wounds due to their ability to accelerate wound healing and their nontoxic nature for humans and the environment. Treated wound dressing allows the removal of moisture and movement of gases to and from the wound area while the antimicrobial agent in it suppresses microbial growth. Extracted Aloe vera components can be applied directly into a fabric or they can be electro spun to nanoparticles that are incorporated into the fabric. Because biological antimicrobial agents like Aloe vera are not highly effective against high concentrations of microorganisms, chemical antimicrobial agents are still used even though they are harmful.

Aloe vera processing using methods like the thermal treatment method makes the Aloe vera lose some of its therapeutic benefits. Natural fabrics treated with Aloe vera can be used as an alternative to chemical agents used for wound treatment. Natural wound dressings treated with natural antimicrobial agents have the advantage of preventing microbial growth while at the same time promoting wound healing without activating the immune response as they are biocompatible.

KEYWORDS: Herbs, Aloe vera, anti-microbial compounds, Medical textiles, wound dressing.

INTRODUCTION

Historically, untreated wound dressings have been used to protect wounds against microbial invasion and mechanical damage by acting as barriers. However, being a barrier is not always effective in preventing microbial invasion; hence the need to incorporate antimicrobial compounds into wound dressings. Once a wound area is invaded by microbes, a minor acute wound can quickly turn into a chronic one which can necessitate the need for major medical treatments. Antimicrobials can be classified into two types: biological and chemical. Biological antimicrobials are extracted from plants whereas chemical ones are synthesized using chemical elements such as silver, copper, zinc oxide, zinc, etc. Chemical antimicrobials can be toxic to humans and the environment hence, biological antimicrobials are a good alternative as they are biocompatible and nontoxic. Amongst the candidates from natural antimicrobials is Aloe vera which contains active compounds that prevent microbial growth and promote wound healing. Aloe vera gel can be easily extracted from the leaves by squeezing the leaves and then coated onto the fabric. This technique is the simplest way to recover compounds and apply them to fabric to impart antimicrobial activity.

ALOE VERA PLANT

The Aloe vera plant is a succulent plant that belongs to the Liliaceae family. It is grown all over the world because of its numerous health and cosmetic benefits. Some people call it an emergency doctor or a natural beautician. There are wide varieties of Aloe vera species, ranging from 360–500, of these species, the Aloe barbadensis Miller, Aloe arborescens Miller, Aloe ferox Miller, Aloe vera var. Aloe vera farming is a big business, and countries that are big growers are Latin American countries, the USA, China, and Thailand.

The most important part of the plant is the long-thick succulent leaves rich in biological compounds. Hence, it is regarded as a global plant. The leaf has three layers, the inner, middle, and outer layers, which contain about 99% water and 1% bioactive compounds. The inner layer comprises the transparent gel, which is rich in components. The middle layer comprises the yellow-bitter sap, which has anthraquinones and glycosides. The outer layer is for protection and enables it to survive in various extreme conditions (hot and dry areas with low rainfall). It can also survive in areas with low freezing temperatures.

ALOE VERA COMPOUNDS

Aloe vera consists of a variety of bioactive compounds. The chemical constituents of Aloe vera and associated properties for various applications with biological properties. There are about 20 minerals, 75 nutrients, 18–20 amino acids, 12 vitamins, and 75–200 active compounds, aloesin, anthraquinones (aloin and aloe-emodin), aloe-mannan, acemannan (gel polysaccharides), mannose-6-phosphate, barbaloin, aloe ride, verectin, gibberellin like substance, aloe resin I, 5-methyl chromone, flavonoids, glycoprotein fraction, anthraglyco- sides, reducing sugars, cardiotonic glycosides, saponins, naphthoquinones, sterols and triterpenoids. Differences in the content of compounds can be due to differences in climate, seasons, and geographic locations. The presence of these compounds makes the Aloe vera plant a good candidate as an antimicrobial, anti-inflammatory, or antioxidant agent. The synergistic effects of compounds make them have a wide variety of health benefits in one plant.

Anthraquinones	The main bioactive compound in the bitter yellow latex of the aloe vera leaf.
Aloe Polysaccharides	The main ingredient in aloe vera gel, with glucose-mannose polysaccharide being the most common.
Chromones	Includes aloesin, umbelliferone, and esculetin
Vitamins	Includes vitamins A, C, E, B12, folic acid, and choline.

Minerals	Includes zinc, copper, selenium, and calcium.
Enzymes	Includes amylase, catalase, and peroxidase.
Sugars	Includes monosaccharides such as mannose-6-phosphate and polysaccharides such as glucomannans.
Fatty Acids	Includes caproic acid, octanoic acid methyl ester, caprylic acid, capric acid, lauric acid, tetradecanoic acid methyl ester, myristic acid, elaidic acid, oleic acid, linoleic acid, and α-Linolenic acid

As stated previously, the broad health benefits and combinations of compounds make Aloe vera an important plant. Seven amino acids a human body cannot synthesize are present in Aloe vera. Amino acids promote wound healing by repairing damaged cells such as wounds. The glycoprotein, mannose-6-phosphate, and acemannan compounds also promote wound healing. Sanchez-Machado et al. reported that they promote wound healing by promoting cell proliferation, vascular endothelial growth factor, and type I collagen. Glycoproteins also have antiallergic properties and suppress histamine that can cause allergic reactions in some people. Mannose 6-phosphate also suppresses inflammation. Other anti-inflammatory compounds in Aloe vera are B-sitosterol, lupeol, emodin, Aloeresin, veracylglucan, cinnamoyl, and glucopyranosyl. Aloe vera has many health benefits and is being explored as a natural wound healing agent incorporated into wound dressings to prevent microbial growth and promote the wound healing process is complicated and requires multiple compounds.

APPLICATION

The simplest application of antimicrobial agents to a wound dressing involves the immersion of the fabric dressing in a solution containing the agent. Another simple way is to spread them on the surface of the fabric dressing that will be in direct contact with the wound. The incorporation of antimicrobial agents into fabric is not permanent, as the antimicrobial activity decreases with increased cleaning cycles. Silk fabric treated with Aloe vera still had its antimicrobial activity after 5 cleaning cycles and cotton fabric treated with Aloe vera nanoparticles has antimicrobial activity even after 10 cleaning cycles. There were no significant changes in the tensile properties at 5 and 10 washes. After 15 and 20 washes, there was a growth of fungus in the fabrics, which can be attributed to the breakage of intermolecular hydrogen bonds within the cellulose molecules. A decrease in tensile properties was reported.

Antimicrobial nanoparticles are also incorporated into the wound dressings, and they are released to the wound area when the dressing is applied. Two methods of generating and incorporating them are physical and chemical. The physical method uses heat, making nanoparticles more stable as the temperature of the particles is kept constant. High heat increases the consumption of electricity. Chemical methods use chemicals and concerns are being raised about their impact on the environment. Biological methods can be an alternative by using bacteria and fungi from plants to synthesize Au, Cd, ZnO, Pb, Pd, Fe, and Ag nanoparticles. Even though the biological method is environmentally friendly, its efficiency is dependent on the growth conditions of microbes, genetics of microbes, and biocatalysts. Electronic sensors can also be incorporated into wound dressings to monitor the healing process. Aloe is used topically (applied to the skin) and orally. Topical use of aloe is promoted for acne, lichen planus (a very itchy rash on the skin or in the mouth), oral submucous fibrosis, burning mouth syndrome, burns, and radiation-induced skin toxicity. Oral use of aloe is promoted for weight loss, diabetes, hepatitis, and inflammatory bowel disease (a group of conditions caused by gut inflammation that includes Crohn's disease and ulcerative colitis.

MEDICINAL USES OF ALOE VERA:

- Wound healing: Aloe vera has wound healing properties.
- Anti-inflammatory: Aloe vera has anti-inflammatory properties.
- Antibacterial: Aloe vera has antibacterial properties.
- Antifungal: Aloe vera has antifungal properties.
- Antiviral: Aloe vera has antiviral properties.
- Antitumor: Aloe vera has antitumor properties.

WOUND DRESSINGS

An ideal wound dressing prevents microbial invasion from the outside environment while simultaneously promoting wound healing by providing a moist environment, absorption of excess fluids, and allowing free movement of gases to regenerate the skin. In burn wounds, microbial invasion can occur within 48 hours. Requirements for the materials are strength, biocompatibility, biodegradability, antimicrobial, nontoxic, and promotion of cell adhesion and proliferation. Wound dressings must also meet the same requirements, in addition to permeability to gases and absorption of exudates. Excessive exudates cause maceration creating an environment favorable for microbial growth.

Wound dressings can be made using synthetic polymers or natural biopolymers. Polymers can be blended to produce dressings with desired properties. Blending takes advantage of individual polymer properties. Natural biopolymers have received huge attention as they are environmentally friendly and do not induce an immunological response. Natural biopolymers are more susceptible to microbial attacks than synthetic ones. Synthetic polymers like polyvinyl and polycaprolactone have received attention as they are biodegradable, biocompatible, and nontoxic. In addition, they have better chemical and physical properties than natural biopolymer. Other factors taken into consideration when it comes to the choice of the polymer are cost, simplicity, and versatility.

The electro spinning technique is widely used to produce Nano fiber membranes used to make wound dressings. A high current is applied to the polymer solution to create a voltage difference which creates the formation of Nano fibers. It consumes a lot of electricity. The synthetic polymer solution can be more easily electro spun than the natural polymer solution. In general, natural polymers tend to have lower mechanical and structural stability than synthetic one. Most electrospun wound dressings are prepared from natural biopolymers such as silk fibroin, alginate, collagen, chitosan, gelatin, hyaluronic acid, and starch because of their better biocompatibility and biodegradability. Aloe vera extract solution on its own cannot be electro spun to make Nano fibers and it must be blended with fiber polymers (spinning agents) to produce Nano fibers. For example, Aloe vera and polycaprolactone are electro spun to produce Nano fibers that can be used as a wound dressing. The Nano fibers mat is permeable, antiseptic, and has good moisture retention. Good permeability allows increased movement of oxygen and moisture which are essential for wound healing. For the electro spun hydroxypropyl methylcellulose membrane, it is reported that when the concentration of Aloe vera was from 2% to 4% and then to 6%, it was accompanied by increases in fabric permeability. Another biocompatible polymer that can be used to produce an antimicrobial membrane for medical applications is chitosan polymer which is electro spun with Aloe vera.

COTTON DRESSING

Cotton, the most common natural fiber, can be treated with antimicrobial to impart antimicrobial activity. Cotton wound dressing treated with Aloe vera incorporated into the oxidized pectin – gelatin gel showed good antimicrobial activity against E. coli and S. aureus, and the wound showed improved cell regeneration. Aloe vera is reported to decrease bacterial growth when its concentration is increased by 20%. However, further increases above 20% did not have a beneficial effect. A cotton fabric treated with Aloe vera, its antimicrobial activity against E. coli and S. aureus did not completely diminish. However, it decreases with an increased number of cleaning cycles. Cotton fabric treated with silver nanoparticles had mixed results against microorganisms. Against E. coli and S. aureus, it was effective at low, medium, and high concentrations.

SILK DRESSING

Natural silk fibers are antimicrobial due to the sericin protein. However, subjecting silk to processing treatment dissolves the sericin and exposes the fibers to microbial attack. To compensate for this loss, formaldehyde can be applied. Unfortunately, it is harmful to the environment, and as such, an environmentally friendly polycarboxylic acid has been suggested as an alternative. Silk fibers have good properties (antimicrobial activity, strength, elasticity, lightweight, drapability, and moisture absorption). These make them good candidates to produce an ideal antimicrobial wound dressing. Nano-silk fibrous membranes can be successfully spun into the wound dressing. Nano silk solution can also be successfully electro spun with Aloe vera or manuka honey to impart antimicrobial activity.

TREATED FABRIC ANTIMICROBIAL ACTIVITY

Aloe vera is one of the few plants that have compounds that can act against bacteria, viruses, and fungi. This makes wound dressings treated with Aloe vera good choices in treating wounds. Antimicrobials prevent microbial growth by altering microorganisms' membranes and protein processes. Aloe vera is effective against microbes, however, if the wound is highly infected; the active compounds are reduced, resulting in the need for synthetic antimicrobials like silver or antibiotics. One of the techniques that can be used to assess the effectiveness of Aloe vera-treated wound dressing against microorganisms is the inhibition zone test.

Antimicrobial activity against bacteria has also been reported for a silk fabric treated with Aloe vera. The treated fabric retained its antimicrobial activity even after repeated washing. Retention of antimicrobials is essential if the treated fabric is going to be used a couple of times and thereby necessitates the need to wash it. Exposing a fabric to liquids is reported to cause a minor loss in fabric strength and abrasion resistance when a liquid antimicrobial is used.

OTHER USES OF ALOE VERA

Other applications of Aloe vera are in the beauty, agricultural, and filtration industries. For the beauty industry, Aloe vera contains compounds that promote cell proliferation. These compounds are used in beauty products to slow aging. In the agricultural sector, it can be used to protect fruits against microbes that cause fruit decay. Treating fruits with Aloe vera gel and chitosan can prolong the fruit shelf life by reducing moisture loss. In the filtration industry, it can be used as a finishing agent on fibrous masks to impart antimicrobial properties to further enhance the mask's protection against microbes. Captured microbes are then deactivated by the Aloe vera antimicrobial compounds. It also reduces the risk of transmitting or contracting infectious pathogens. In the clothing industry, Aloe vera has found some applications. The ultraviolet protection factor (UPF) of a fabric treated with Aloe vera is 8× higher than that of an untreated one; due to the presence of polyphenols in Aloe vera; that block and absorb the UV rays. It shows that wound dressings treated with Aloe vera have protection against UV rays.

CONCLUSION

The use of natural wound dressings treated with Aloe vera suppresses microbial growth while at the same time promoting wound healing. Discussions have shown that Aloe vera is a good alternative that imparts antimicrobial activity to wound dressings. In contrast, traditional chemical antimicrobials are a risk to the environment and people. They are toxic, non-biocompatible, and non-biodegradable. Some of the shortcomings of using Aloe vera as antimicrobials are their susceptibility to heat and air. In addition, their concentrations vary from plant to plant. Despite these challenges, it was demonstrated that wound dressings treated with Aloe vera suppress the growth of microbes.

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ARTIFICIAL INTELLIGENCE-POWERED ECO-FRIENDLY CLOTHES SOLUTIONS FOR MORAL CLOTHING PRODUCTION

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ABSTRACT

Despite its reputation for innovation and vibrancy, the fashion sector is one of the biggest causes of environmental damage. There are several unsustainable activities in the traditional fashion supply chain, ranging from excessive water use to waste production and greenhouse gas emissions. This essay explores how artificial intelligence (AI) might act as a driving force behind the fashion industry's transition to a more ethical and sustainable sector. Applications of AI in material innovation, design optimisation, manufacturing procedures, supply chain transparency, and customer involvement are all covered in detail. For example, generative design tools minimise waste by making the best use of fabric, while AI-driven algorithms may find and create environmentally friendly material. Furthermore, AI ensures ethical sourcing and effective inventory management by improving supply chain transparency with blockchain technology and predictive analytics. AI-powered consumer interaction solutions teach customers about sustainable options while also personalising their buying experiences. AI integration has the ability to completely transform the sector, despite certain obstacles like data privacy issues and financial ramifications. The article also discusses practical uses, such as case studies of companies using AI to promote sustainable business practices and the growing field of circular fashion. This article highlights AI's involvement in guiding the fashion industry towards a more sustainable and fair future by providing a thorough examination of these advancements.

Keywords: Sustainable Fashion, Artificial Intelligence, AI Applications, Eco-Friendly Materials, Fashion Technology.

INTRODUCTION

The fashion business is one of the most resource-intensive and environmentally damaging industries in the world, despite its reputation for creativity and innovation. It is in charge of around 20% of wastewater production and 10% of carbon emissions worldwide. Fast fashion's growth and the quick changes in fashion trends have made problems like resource depletion, labour exploitation, and textile waste worse. Stakeholders in the sector are looking for creative answers to these problems as the need for more sustainable practices grow.

A game-changing technology, artificial intelligence (AI) has the potential to completely change how the fashion industry approaches sustainability. AI is a potent instrument for promoting productivity and creativity because of its capacity to analyse enormous volumes of data, spot trends, and offer useful insights. Applications of AI are numerous and significant, ranging from creating environmentally friendly materials to streamlining manufacturing procedures and improving supply chain transparency.

This study examines how AI is incorporated into several facets of the fashion lifecycle, emphasising how technology may support ethical and environmentally friendly practices. In order to demonstrate how AI may assist in transforming the fashion industry into one that is more sustainable and ethical, the paper will look at real-world examples, technology developments, and possible obstacles. AI stands out as a key facilitator for the fashion industry's shift to a more sustainable and just future as the worldwide call for sustainability becomes stronger.

AI in the Development of Sustainable Materials.

Material Discovery and Development:

AI is transforming material science by making it possible to find and create novel, sustainable materials. It frequently takes a lot of time and resources to identify new materials using traditional approaches. However, this process can be greatly accelerated by AI algorithms, which can analyse enormous databases of material properties, find patterns, and forecast outcomes. AI-driven technologies, for example, may model how possible materials might behave in different scenarios, selecting those that satisfy particular sustainability standards like biodegradability, recyclability, and low environmental impact.

The creation of lab-grown materials is one of the innovative uses of AI. AI aids in the development of environmentally friendly substitutes for traditional materials, such as biofabricated leather and mycelium-based textiles, by evaluating biological data and modelling growth patterns. In a same vein, AI makes it easier to create recycled fabrics by identifying the best fibre combinations that optimise sustainability, strength, and durability.

Improving material efficiency is mostly dependent on machine learning models. These algorithms are able to evaluate the characteristics of fibres and recommend blends that strike a balance between environmental friendliness and durability. For instance, combining natural fibres with recycled synthetics can produce strong, high-performance textiles that are also environmentally friendly. Additionally, by streamlining procedures to cut down on waste and energy use, AI helps to minimise the environmental impact of material production.

In addition to quickening the rate of material innovation, AI's utilisation of these skills guarantees that the final products adhere to the circular economy and sustainability tenets.

Material Efficiency

A key component of sustainable fashion is material efficiency, which addresses the need to reduce waste and maximise resource use throughout production. By providing accurate, data-driven answers, AI-driven tools and technologies are essential for improving material efficiency. Pattern optimisation is one important area where AI is being used. Cutting-edge software can evaluate clothing designs and produce plans that optimise fabric use, greatly lowering production waste and offcuts. Because of this optimisation, every square inch of material is used efficiently, which lowers costs and promotes environmental sustainability.

AI also makes it easier to monitor and modify industrial processes in real time. AI-powered smart manufacturing systems may monitor material use throughout fabrication, pinpointing inefficient locations and recommending fixes. AI, for example, may identify variations in fabric thickness or quality, enabling producers to fix problems before substantial material loss happens. Additionally, producers can match material procurement with demand projections thanks to AI-powered predictive analytics. Businesses may prevent over-purchasing, which frequently results in excess inventory and waste, by precisely forecasting the amount of resources required for production. This method lessens the negative effects of excess output on the environment while simultaneously reducing resource waste.

Reusing and upcycling are two more creative uses. Artificial intelligence (AI) systems are capable of classifying and sorting textile waste, finding materials that can be recycled or used again to create new goods. A circular economy paradigm, in which resources are continuously reused rather than discarded, is supported by this skill. The garment sector can drastically lower its environmental impact, maximise cost savings, and encourage sustainable practices throughout the value chain by utilising AI for material efficiency.

AI in Design and Production

1. **Design Optimization**:
   - **Generative Design Software**: Generative design techniques powered by AI produce complex structures and patterns that maximise the use of available materials. By using algorithms to investigate various design options, these tools guarantee the most effective use of textiles or raw materials. In addition to reducing waste, this improves the finished product's appearance and usefulness.
   - **Virtual Prototyping**: Virtual prototyping is now a crucial step in the design process thanks to AI. Without requiring tangible samples, this technology enables designers to test and simulate different concepts in a virtual setting. This allows for quick changes and revisions while saving resources like time, money, and materials. This guarantees that before designs are put into production, they satisfy particular performance, durability, and comfort requirements.
2. **Automation in Production**:
   - **Smart Manufacturing Systems**: Smart manufacturing systems with AI capabilities automate a number of production procedures, increasing accuracy and efficiency. These systems optimise workflows, minimise downtime, and guarantee smooth operations by utilising real-time data and predictive analytics.
   - **Enhanced Precision and Sustainability**: From cutting and stitching to quality control, AI-driven automation helps reduce human error and ensures high levels of accuracy throughout the production process. Smart systems also optimise energy use, which lessens the impact on the environment and encourages sustainable production methods.
   - **Continuous Improvement**: AI enables machine learning to continuously improve manufacturing processes, creating adaptable systems that can react quickly to shifting market demands and production requirements.

AI in Supply Chain Transparency

1. **Traceability and Ethical Sourcing:**
   - **Blockchain Technology:** Blockchain solutions driven by AI offer an unchangeable and transparent record of the movement of raw materials and final goods. This guarantees end-to-end traceability, enabling companies to confirm the source of resources and guarantee adherence to labour laws, sustainability objectives, and ethical norms.
   - **Predictive Analytics:** Predictive analytics, which makes use of sophisticated AI, assists in locating supply chain inefficiencies and possible environmental effects. By enabling proactive actions like waste reduction, carbon footprint minimisation, and resource optimisation, these insights guarantee a more sustainable and accountable supply chain.
2. **Inventory Management:**
   - **Demand Forecasting:** To precisely forecast demand, AI algorithms examine past data, industry trends, and consumer behaviour. This aids in resource optimisation, cost-efficiency improvement, and the reduction of unsold inventories and overproduction. Businesses can optimise operations and cut waste by modifying production schedules and stock levels based on their anticipation of future demand.

AI in Consumer Engagement

1. **Personalization and Recommendations:**
   - **AI-Driven Platforms:** Platforms driven by AI provide customers with individualised sustainable fashion options based on their tastes, fashion sense, and habits. These suggestions, which are produced by sophisticated data analysis, guarantee that customers receive environmentally friendly goods that complement their values and way of life. These platforms improve the buying experience by comprehending individual demands, which increases the accessibility and appeal of sustainability.
2. **Education and Awareness:**
   - **Virtual Assistants and Chatbots:** Chatbots and virtual assistants driven by AI are crucial in teaching customers about sustainable business practices. They offer knowledge on subjects including ethical sourcing, environmentally friendly products, and the advantages of responsible consumption. This promotes ethical buying practices and raises consumer awareness, creating a more knowledgeable and sustainable community.

Challenges and Ethical Considerations

1. **Data Privacy:**
   - **Safeguarding Consumer Information:** Large datasets are essential to the efficient operation of AI systems, which raises questions regarding data security and privacy. Strong security measures must be put in place to guard against misuse, breaches, and illegal access to customer data. To preserve trust and ethical standards, businesses must put an emphasis on openness, secure informed permission, and make sure that data protection laws are followed.
2. **Bias in Algorithms:**
   - **Ensuring Inclusivity:** If AI algorithms are not properly developed, they may reinforce prejudices based on age, gender, ethnicity, or other traits, producing discriminatory results. To guarantee inclusion and fairness and to promote equitable experiences for all customers, efforts must be taken to construct objective models using a variety of datasets, rigorous testing, and ongoing monitoring.
3. **Economic Implications:**
   - **Workforce Adaptation:** Traditional positions may be replaced by AI-driven systems, which could cause major changes in labour markets. To guarantee a smooth transition into new, AI-integrated jobs, workforce adaption methods like upskilling programs, reskilling efforts, and support systems for impacted employees must be put in place as automation and smart technologies replace manual procedures.

Case Studies and Practical Applications

1. **Brands Implementing AI**:
   - **Stella McCartney and H&M**: To improve sustainability, some well-known fashion firms have effectively integrated AI into their business processes. While H&M uses AI to forecast fashion trends and cut down on waste and overproduction, Stella McCartney uses AI to create creative, environmentally friendly materials. These companies are able to produce more environmentally friendly goods that meet consumer demands and environmental aims by utilising AI.

2. **AI in Circular Fashion**:
    - **Circular Fashion Initiatives**: AI is essential for encouraging upcycling and recycling in the context of circular fashion. Artificial intelligence (AI)-powered tools examine used clothing to find recyclable elements and make it easier to create new goods from already-existing resources. This strategy minimises the impact on the environment and lowers the demand for new resources by supporting a closed-loop system in which clothing is reused or recycled.

Conclusion

AI offers unmatched potential to revolutionise the apparel industry's sustainability strategy. AI tackles important ethical and environmental issues by streamlining production, improving transparency, encouraging circular fashion, and optimising design. The sector can guarantee ethical sourcing, cut waste, and produce more sustainable goods by utilising cutting-edge technologies. All parties involved—designers, producers, legislators, and consumers—must work together to fully realise AI's promise. The fashion industry can advance towards a more fair and sustainable future by working together, encouraging innovation while upholding social and environmental responsibility.

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WIRELESS COMMUNICATION AND CONNECTIVITY IN SMART TEXTILES AND ROBOTIC WEARABLE - TEXTILE-BASED SOFT ROBOTICS FOR REHABILITATION

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ABSTRACT

The rapid development of **smart textiles** and **wearable robotics** has opened up new avenues for assisting individuals with mobility impairments. This paper explores the integration of **wireless communication** and connectivity into **textile-based soft robotics** for **rehabilitation applications**. We examine the role of **wearable soft robotic devices**, emphasizing their ability to provide **personalized rehabilitation** while maintaining flexibility, comfort, and ease of use. Key challenges such as power efficiency, real-time monitoring, and **remote connectivity** are addressed, with a focus on innovative solutions such as **flexible sensors**, **energy harvesting**, and **IoT integration**. We conclude by evaluating the future potential of **robotic wearables** that leverage **smart textile technologies** for both therapeutic and functional purposes in rehabilitation settings.

Keywords: Smart textiles, wearable robotics, soft robotics, wireless communication, rehabilitation, assistive devices, wireless connectivity, textile-based actuators, rehabilitation technology, wearable exoskeletons.

INTRODUCTIONS

Wearable technologies, particularly in the realm of **rehabilitation**, have witnessed significant advancements over the past decade. Among these innovations, **soft robotics** integrated with **smart textiles** stands out for its potential to offer users adaptive, comfortable, and effective assistance. **Soft robotics** typically uses flexible and deformable materials such as **textiles** and **polymers**, enabling devices to conform to the human body while maintaining the necessary mechanical properties for mobility assistance.

Recent advancements in wireless communication and connectivity have further enhanced these devices' capabilities, enabling **remote monitoring**, **data collection**, and **real-time feedback** to users and healthcare providers. This synergy between **smart textiles**, **wireless communication**, and **soft robotics** holds immense promise in revolutionizing rehabilitation technologies.

1. Background and Related Work
1.1 Smart Textiles in Wearable Technologies

Smart textiles integrate electronic components, such as sensors, actuators, and communication modules, directly into fabrics. These textiles can sense environmental changes (e.g., temperature, pressure, motion) and respond accordingly, making them ideal candidates for wearable rehabilitation devices. Wearable systems utilizing **smart textiles** can track health metrics, assist with mobility, and provide feedback to both the user and healthcare professionals.

1.1.1 Types of Smart Textiles

- **Active Smart Textiles**: These textiles can react to external stimuli by changing their properties. For example, **temperature-responsive fabrics** that expand or contract based on heat levels or **light-responsive materials** that change color.
- **Passive Smart Textiles**: These do not actively change their properties but are able to **sense environmental conditions**. Examples include fabrics embedded with sensors to monitor **body temperature** or **heart rate**.
- **Ultra-Smart Textiles**: These are capable of sensing and responding to stimuli in real-time. They can also process and store data or even communicate with external devices, acting as part of a **wearable system**.

1.1.2 Applications of Smart Textiles

Healthcare and Medicine:

1. **Vital sign monitoring**: Garments integrated with sensors to track **heart rate**, **respiratory rate**, and **blood pressure** in real-time.
2. **Chronic disease management**: Smart textiles can help monitor conditions like **diabetes** or **epilepsy**, alerting users or caregivers when intervention is needed.
3. **Rehabilitation**: Smart fabrics embedded in wearable **exoskeletons** or **prosthetics** to assist with movement tracking and rehabilitation.

Fig. 1

Sports and Fitness:

1. **Performance monitoring**: Smart clothing embedded with sensors to track **muscle activity**, **movement**, **posture**, and **fatigue** during physical activities.
2. **Athlete recovery**: Smart textiles can apply **compressive force** or monitor **muscle strain** to aid in recovery after exercise.

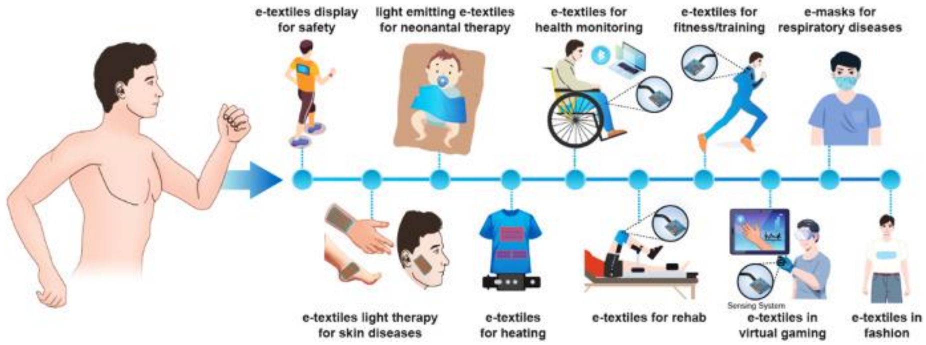

Fig. 2

Fashion and Design:

1. **Interactive clothing**: Textiles that change color, texture, or shape based on user interaction or environmental factors.
2. **Fashionable wearables**: Clothing that incorporates **LED displays**, **temperature regulation**, or **health sensors** without compromising style.

Fig. 3

Military and Safety:

1. **Uniforms with embedded sensors**: Smart textiles in military or emergency service uniforms to monitor vital signs, detect environmental hazards, and enhance situational awareness.
2. **Protective wear**: **Wearable armor** that adjusts based on external conditions, such as **temperature-sensitive fabrics** that provide **cooling or heating.**

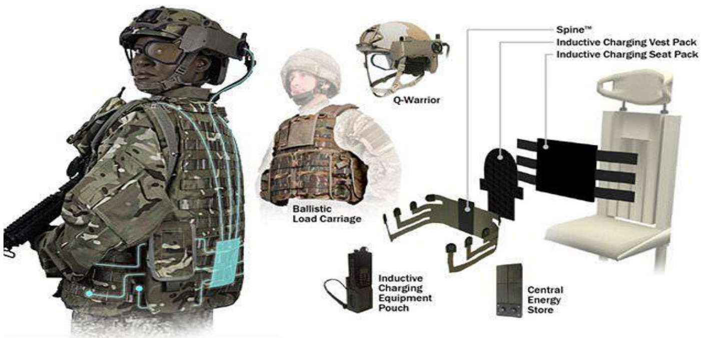

Fig. 4

1.1.3 Technologies Used in Smart Textiles

Conductive Fibers:

Fibers that can transmit electrical signals, allowing for **sensing and communication** within the textile. They are often used in **wires**, **sensors**, or **heating elements**.

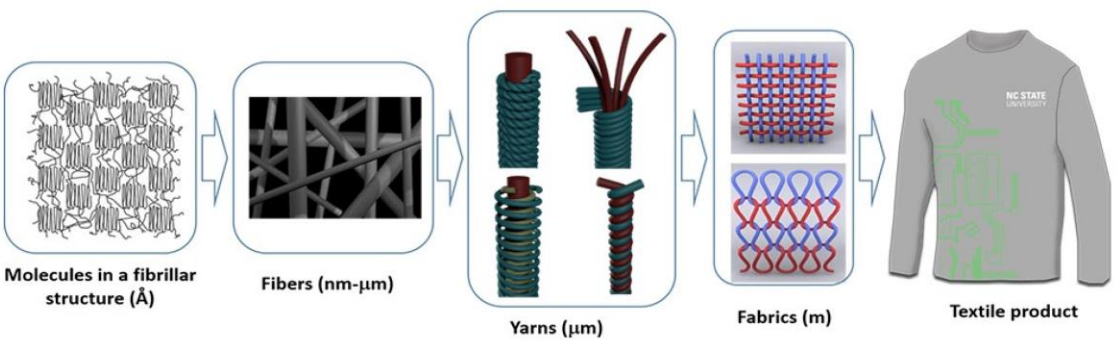

Fig. 5

Nanotechnology:

The use of nanoparticles or **nanowires** within textiles enhances their **sensing capabilities**, making them more responsive, durable, and functional for wearable applications.

Fig. 6

Flexible Electronics:

Thin, lightweight electronic components integrated into fabrics, such as **flexible circuits**, **OLEDs (Organic Light Emitting Diodes)**, and **microcontrollers**, which allow garments to perform complex functions without adding bulk.

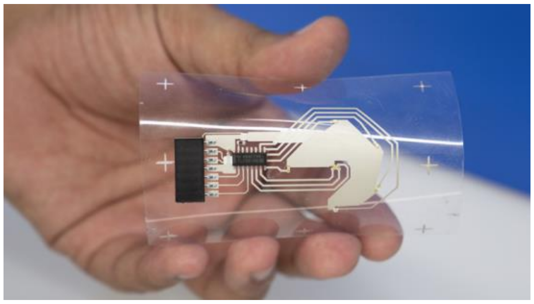

Fig. 7

Energy Harvesting:

Piezoelectric materials, **solar cells**, and **thermoelectric generators** embedded in fabrics to **harvest energy** from the user's movements or the environment, powering sensors or communication systems.

1.2 Soft Robotics for Rehabilitation

Soft robotics, a sub-field of robotics, is characterized by its use of **compliant** and **flexible materials** for actuation. These robots are less rigid and more adaptable than traditional rigid robots, making them safer and more comfortable for users in rehabilitation scenarios. For example, soft robotic exoskeletons have been developed to assist individuals with mobility impairments by supporting and enhancing movements through **wearable devices**.

1.3 Wireless Communication and IoT in Wearables

Wireless communication systems, including **Bluetooth**, **Wi-Fi**, and **5G** technologies, are essential for the functionality of smart wearable devices. These technologies allow for **real-time data transfer**, **remote monitoring**, and **feedback mechanisms**. The integration of these systems into textile-based soft robotics has enabled users to benefit from **continuous health monitoring** and **adaptive rehabilitation** without being constrained by wired connections.

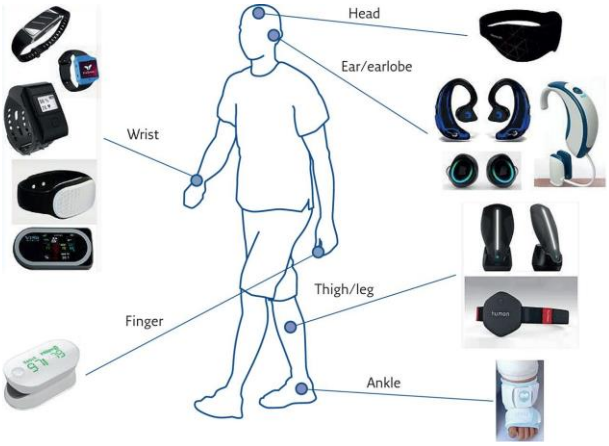

Fig. 8

2. Materials and Methods

2.1 Textile-Based Soft Robotics

For the development of textile-based soft robotics, **conductive fabrics**, **piezoelectric materials**, and **actuators** such as **shape-memory alloys (SMAs)** or **hydraulic actuators** are used. These materials allow the robot to adapt to user movements, providing **flexible, lightweight, and energy-efficient solutions** for rehabilitation. Soft robotic components are embedded into textiles in a way that ensures comfort and flexibility for users.

2.2 Wireless Communication Framework

A **wireless communication network** using **Bluetooth Low Energy (BLE)** or **ZigBee** is implemented for seamless data exchange between the wearable device and a **mobile application** or **cloud platform**. Sensors embedded in the smart textiles gather data on the user's motion, joint angles, and other vital signs, which is then transmitted wirelessly for real-time analysis. A **cloud-based dashboard** allows clinicians to monitor patient progress remotely and make necessary adjustments to therapy programs.

2.3 Power Management and Energy Harvesting

Efficient power management is critical for wearable devices, especially for long-term use in rehabilitation settings. **Energy harvesting technologies**, such as **piezoelectric generators** or **solar panels**, are integrated into the device to recharge batteries using body movements or environmental factors. This reduces the reliance on external charging sources and makes the device more convenient for continuous use.

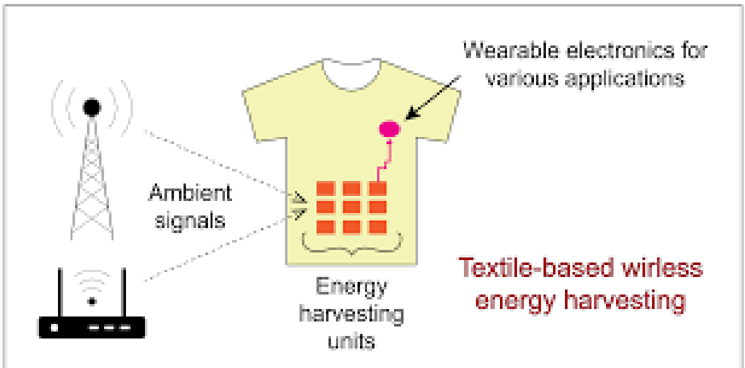

Fig. 9

3. Textile-Based Soft Robotics for Rehabilitation

Textile-based soft robotics represents a transformative approach in rehabilitation technology, merging the flexibility of textiles with the adaptability of soft robotics. Unlike traditional rigid exoskeletons, these systems utilize compliant and lightweight materials, such as elastic fabrics and shape-memory alloys, to mimic natural body movements. This makes them particularly suited for individuals recovering from injuries or those with mobility impairments, as they provide gentle, adaptive assistance while ensuring comfort and ease of use. The integration of sensors and actuators within the fabric enables precise monitoring of joint angles, muscle activity, and movement patterns, allowing for tailored therapeutic interventions. Moreover, textile-based soft robotic wearables often incorporate wireless communication systems, enabling real-time data transmission to healthcare professionals for remote monitoring and adjustments. This technology not only enhances the rehabilitation experience but also promotes long-term adherence by offering a more natural and intuitive interface between the user and the device. As advancements in materials science and embedded electronics continue, textile-based soft robotics holds the potential to redefine personalized rehabilitation and assistive care.

Fig. 10

4. Results and Discussion

4.1 Prototype Development and Testing

A prototype of a **textile-based soft robotic exoskeleton** was developed with integrated **smart textiles** for a **lower-limb rehabilitation system**. The device used **conductive fabric sensors** to detect joint angles and **force feedback actuators** to assist with motion. Wireless communication modules allowed for **remote monitoring** of performance metrics, including **muscle activity**, **joint stress**, and **movement speed**.

Preliminary testing demonstrated that the wearable system effectively supported **patients recovering from lower-limb injuries** by providing tailored assistance during rehabilitation exercises. The integration of wireless connectivity enabled clinicians to track patient progress and adjust the rehabilitation protocols as needed.

4.2 Benefits of Wireless Connectivity in Rehabilitation

Wireless communication enables a more personalized rehabilitation experience. Real-time data collection and remote feedback allow clinicians to intervene promptly and adjust the therapy according to the patient's progress. Moreover, the **comfort and flexibility** of the textile-based exoskeletons ensure that users can wear them for extended periods without discomfort, promoting better compliance with rehabilitation protocols.

4.3 Challenges and Limitations

While the integration of wireless communication and soft robotics into wearable rehabilitation devices shows promise, challenges remain. One key challenge is **battery life**, as continuous operation of wireless sensors and actuators can drain power quickly. Additionally, the accuracy and **reliability of wireless communication** can be affected by **interference** or **signal loss**, which may impact real-time feedback.

5. Future Trends

Integration with IoT (Internet of Things):

The future of smart textiles lies in their ability to connect seamlessly with the **Internet of Things** (IoT), enabling continuous data exchange with other smart devices like smartphones, health monitors, and medical systems.

AI and Machine Learning:

Smart textiles will increasingly incorporate **artificial intelligence (AI)** to analyze data in real-time, providing **personalized feedback** and **predictive health insights** based on individual user behavior and environmental conditions.

Sustainability:

As demand for smart textiles grows, the industry will focus on **sustainable materials** and **eco-friendly manufacturing processes**, reducing the environmental impact of producing high-tech fabrics.

CONCLUSION

The combination of **smart textiles**, **soft robotics**, and **wireless communication** represents a significant advancement in the field of rehabilitation technologies. By integrating these elements, wearable robotic systems can offer personalized, adaptive rehabilitation therapies that improve patient outcomes. Future work should focus on enhancing **battery life**, **sensor accuracy**, and **data security** for remote monitoring. Furthermore, **machine learning** algorithms could be integrated into the system to improve the personalization and adaptability of rehabilitation programs based on individual patient data.

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FASHIONING THE FUTURE THE ROLE OF TEXTILE DESIGN IN SHAPING THE INDUSTRY

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ABSTRACT

The main focus of the article concerns the perception and realization of new pedagogy for a fashion academy studio within the field of Arts, Design, Architecture, and Fashion Design and modelling. The use of textile research-based pedagogy, including the application of materials and their utilization of materials and textile techniques, can contribute to the instability of the fashion design framework. Students can therefore be able to learn by interacting with the textile and its related aspects for them to fully understand the craft of fashion. On top of that, this habitude, we call it textile thinking, can lead to a novel trend of fashion designing that will integrate techniques and artistic ideas as well as fashion casting and exhibition performances. The integral element of the learning process that allows the perception of practical managing as a process of the suitable integration of theoretically and practically formed data through the mechanism of reflective learning has formed the basis of the hands-on studio pedagogy. Fashion business classes can be taught based on the basics of textiles scientifically proved by epidemiological studies-which include knits, embroideries, prints, and other finishing techniques to get an understanding of the manufacturing process, in addition to industrial needs. Such projects are forced to mix industrial production knowledge with scholars neatly. This research illuminates how students, tutors, and classrooms play a role in fashion expression as reflected in textile thoughts through a mix of instructor's reflections, student interviews, and observations. In addition, the learning outcomes have been equated to the curriculum transformation so that you can draw a picture in your mind about such a process.

Keywords: Fashion Design, Textile, Fashion Pedagogy, Fashion Style, Modelling, Model Casting

INTRODUCTION

The medium, through which fashion is represented, is becoming prevalent and wearing new shapes and the passion behind this study comes from a desire to better understand how fashion expression intersects with textile design as both aspects are particularly relevant to the main subject at hand as if a three-pronged approach to the communication between clothing and materials can be demonstrated These methods are called "textile-led", "garment-led" and "simultaneous". "Textile-led" means that the fabric is incorporated in the design through the fabric characteristics like pattern or texture of the fabric, fabric colour, fabric weight, and so on. "Garment-led" names garments, whose shape is a determining factor for both in contrast, there are differences in the meaning of these two yet they are being used together. On the contrary, "simultaneous" is understood to be a process that takes both the perspectives and the design of the process into consideration and in which they are all done simultaneously However, we can better comprehend the meaning of merging textile design with fashion if we consider the basic idea of expository communication through it. Within the group of several different ways used, the creation of a series could be derived or even an individual piece of clothing. Not to mention that for professional designers, the fabric is often chosen months in advance with due consideration given to the delivery cycle, it can be only natural for school kids to emulate this kind of fabric-centred approach. In fashion design, fabrics and garments are mirror images of each other and therefore, must entrain one another before declaring each other metaphorical in order to fit. It is necessary that fashion designers should be endowed both with a tactile sense (acquired through fabric handling), and a profound understanding of how the properties of fabric, textile structure, and materials affect the shape and function of the final garment. Geared toward fashion in textiles, the concept of thinking textile is used in the building of garments and collections The process entails starting with the making of the textiles and includes the attributes; both the patterns the textiles make and the patterns they bring into the physical appearance of the garments. At the same time, the slight patterns that the textiles and the colours bring about are the inspiration that produces the overall physical appearance of the collection. Participation in fibre arts is an efficient and powerful tool for characterizing the taste and creativity of a fashion designer, as well as displaying his master ship in the area of material.

TEXTILE AND FASHION DESIGN

Being a textile thinker relevant to the body involves the embodiment of material processes in textile production either through the body or through many other hands. Social skills, tooling, and hand-eye coordination are the important parts that a person undergoes in the Textile of Thinking learning journey. The author then talks about nine types of textile thinking, which are rooted in these pre-existing concepts. These categories are felting, spinning, sewing, plaiting, and weaving, cutting, knotting/knitting, and styling. By choosing "the textile toolbox" as a new epistemic foundation of arts, practitioners' knowledge and experience will come from their abusive review done by historians and theorists. Utilizing studio mode, the course ensures students grasp an embodiment of taking textile medium as a mediator of theory and practice with a vital and subtle knowledge of the material through experience and conscious understanding of the mock process. Practitioners of creativity are endowed with both personal and accumulated knowledge, which is a construct of theoretical and intuitive wisdom. The manner creative textile thinking can invent new material movements and enable the previously absent or hidden qualities of materials to surface and switch to sensory leisure is undeniable. Tacit knowledge is a term that refers to the actions-based and undeclared information similar to the experiential kind. Detailed design knowledge based on body mechanics and haptic sensuality is the basis for the studio instruction. In-depth design knowledge, the body's function, and haptic sensory experiences provide the foundation for practical studio instruction.

FASHION, MODELING, AND STYLE

Social capital is a vital concept in fashion and really in business in general, which in various ways contributes to increasing or limiting the prospects for both men and women, based on the results of this study. Nevertheless, despite the alteration of certain concepts into popular ideas regarding social capital, some basic changes in the workplace, for instance, the transition from the industrial economy to a post–knowledge economy have not been taken into account. The capitals of the gig economy have made employment insecure by reducing job tenure, broadcasting independent contractors and freelancers, and wasting non-standard working patterns. The newly defined economy rests on informality, and this determines the significance of the existing organization of employment in the information era. The expansion of pinpointed issues discussed in this paper

included the earlier studies into the role of affiliation or networking on the careers of creators and ideas such as an open platform for sharing fashion trends and fashion shows. However, a rapid pace of short-term work does grow certain temporary subgroups, like the models and actors that come together suddenly, work for some time, and then vanish. Their level of probabilities of success is varied according to the area of application. Adopting this view, it is truly observed that the great utility, known as the concept of the "transitory ties" which are the frequent, short-term, and very meaningful social links that take place have almost all the practical benefits or utilized by dress models, who make use of these bonds interact with gatekeepers as well as present status and signal through role modelling. The study put forth is a result of ethnographic recordings of fashion shows and castings and also individual interview information.
Additionally, models' smash hits networks illustrated a considerable effect on their career success probability despite the application of social networks and visualization controls, such as fashion house connections, media attention, and public notability. They expand the basic meaning of social relations beyond its normal strength usable indicator to either repetition or categorical change nowadays looking at the employability aspect.

KEY SECTORS OF THE FASHION INDUSTRY

TEXTILE DESIGN AND PRODUCTION

Most fashions are made from textiles. The partial automation of the spinning and weaving of wool, cotton, and other natural fibres was one of the first accomplishments of the Industrial Revolution in the 18th century. In the 21st century those processes are highly automated and carried out by computer-controlled high-speed machinery. A large sector of the textile industry produces fabrics for use in apparel. Both natural fibres (such as wool, cotton, silk, and linen) and synthetic fibres (such as nylon, acrylic, and polyester) are used. A growing interest in sustainable fashion (or “eco-fashion”) led to greater use of environmentally friendly fibres, such as hemp. High-tech synthetic fabrics confer such properties as moisture wicking (e.g., Coolmax), stain resistance (e.g., 303 High Tech Fabric Guard), retention or dissipation of body heat, and protection against fire, weapons (e.g., Kevlar), cold (e.g., Thinsulate), ultraviolet radiation (Solarweave), and other hazards. Fabrics are produced with a wide range of effects through dyeing, weaving, printing, and other manufacturing and finishing processes. Together with fashion forecasters, textile manufacturers work well in advance of the apparel production cycle to create fabrics with colours, textures, and other qualities that anticipate consumer demand.

FASHION DESIGN AND MANUFACTURING

Historically, very few fashion designers have become famous “name” designers, such as Coco Chanel or Calvin Klein, who create prestigious high-fashion collections, whether couture or prêt-á-porter (“ready-to-wear”). These designers are influential in setting trends in fashion, but, contrary to popular belief, they do not dictate new styles; rather, they endeavour to design clothes that will meet consumer demand. The vast majority of designers work in anonymity for manufacturers, as part of design teams, adapting trendsetting styles into marketable garments for average consumers. Designers draw inspiration from a wide range of sources, including film and television costumes, street styles, and active sportswear. For most designers, traditional design methods, such as doing sketches on paper and draping fabric on mannequins, have been supplemented or replaced by computer-assisted design techniques. These allow designers to rapidly make changes to a proposed design's silhouette, fabric, trimmings, and other elements and afford them the ability to instantaneously share the proposed changes with colleagues—whether in the next room or on another continent. Only a minuscule number of designers and manufacturers produce innovative high-fashion apparel. An even smaller number (mostly in Paris) produce haute couture. Most manufacturers produce moderate-priced or budget apparel. Some companies use their own production facilities for some or all of the manufacturing process, but most rely on separately owned manufacturing firms or contractors to produce garments to the fashion company's specifications. In the field of women's apparel, manufacturers typically produce several product lines (collections) a year, which they deliver to retailers at predetermined times of the year. Some "fast fashion" manufacturers produce new merchandise even more frequently. An entire product development team is involved in planning a line and developing the designs. The materials (fabric, linings, buttons, etc.) need to be sourced and ordered, and samples need to be made for presentation to retail buyers.

An important stage in garment production is the translation of the clothing design into a pattern in a range of sizes. Because the proportions of the human body change with increases or decreases in weight, patterns cannot simply be scaled up or down uniformly from a basic template. Pattern making was traditionally a highly skilled profession. In the early 21st century, despite innovations in computer programming, designs in larger sizes are difficult to adjust for every figure. Whatever the size, the pattern—whether drawn on paper or programmed as a set of computer instructions—determines how fabric is cut into the pieces that will be joined to make a garment. For all but the most expensive clothing, fabric cutting is accomplished by computer-guided knives or high-intensity lasers that can cut many layers of fabric at once.

The next stage of production involves the assembly of the garment. Here too, technological innovation, including the development of computer-guided machinery, resulted in the automation of some stages of garment assembly. Nevertheless, the fundamental process of sewing remains labour-intensive. This puts inexorable pressure on clothing manufacturers to seek out low-wage environments for the location of their factories, where issues of industrial safety and the exploitation of workers often arise. The fashion industry in New York City was dominated by sweatshops located on the Lower East Side until the Triangle shirtwaist factory fire of 1911 led to greater unionization and regulation of the industry in the United States. In the late 20th century China emerged as the world's largest producer of clothing because of its low labour costs and highly disciplined workforce.

Assembled garments go through various processes collectively known as "finishing." These include the addition of decorative elements (embroidery, beading); buttons and buttonholes, hooks and eyes, snaps, zippers, and other fasteners; hems and cuffs; and brand-name labels and other labels (often legally required) specifying fibre content, laundry instructions, and country of manufacture. Finished garments are then pressed and packed for shipment.

FASHION SHOWS

Fashion designers and manufacturers promote their clothes not only to retailers (such as fashion buyers) but also to the media (fashion journalists) and directly to customers. Already in the late

19th century, Paris couture houses began to offer their clients private viewings of the latest fashions. By the early 20th century, not only couture houses but also department stores regularly put on fashion shows with professional models. In imitation of Parisian couturiers, ready-to-wear designers in other countries also began mounting fashion shows for an audience that combined private clients, journalists, and buyers. In the late 20th and early 21st centuries, fashion shows became more elaborate and theatrical, were held in larger venues with specially constructed elevated runways ("catwalks") for the models, and played an increasingly prominent role in the presentation of new fashions.

By the early 21st century, fashion shows were a regular part of the fashion calendar. The couture shows, held twice a year in Paris (in January and July) by the official syndicate of couture designers (comprising the most exclusive and expensive fashion houses), present outfits that might be ordered by potential clients but which often are intended more to showcase the designers' ideas about fashion trends and brand image. Ready-to-wear fashion shows, separately presenting both women's and men's wear, are held during spring and fall "Fashion Weeks," of which the most important take place in Paris, Milan, New York, and London. However, there are literally dozens of other Fashion Weeks internationally—from Tokyo to São Paolo. These shows, of much greater commercial importance than the couture shows, are aimed primarily at fashion journalists and at buyers for department stores, wholesalers, and other major markets. Extensively covered in the media, fashion shows both reflect and advance the direction of fashion change. Photographs and videos of fashion shows are instantaneously transmitted to mass-market producers who produce inexpensive clothing copied from or inspired by the runway designs.

WORLD FASHION

Most people in the world today wear what can be described as "world fashion," a simplified and very low-cost version of Western clothing, often a T-shirt with pants or a skirt, manufactured on a mass scale. However, there are also numerous smaller and specialized fashion industries in various parts of the world that cater to specific national, regional, ethnic, or religious markets. Examples include the design, production, and marketing of saris in India and of boubous in Senegal. These industries operate in parallel with the global fashion industry on a minor and localized scale. One significant development in the field of ethno-religious dress was widespread adoption of the hijab (religiously appropriate attire) among Muslim women not only in the Middle East but throughout the Islamic world in the early 21st century. With millions of Muslim women living in numerous countries worldwide, veiling norms and styles are myriad. For some, veiling can mean a withdrawal from the vicissitudes of fashion altogether. Other women, including those for whom modest garments are obligatory in public, may wear fashionable European styles underneath their more conservative street attire. Still others have sought looks that are themselves both chic and modest. At the beginning of the 21st century the international market for modest fashions was growing. Muslim and non-Muslim designers produced a widening selection of appropriate and stylish looks, and numerous fashion blogs and magazines targeting Muslim women became available. Some designers and manufacturers confronted not only the aesthetics of modest attire but also the practical challenges associated with conservative dress, as seen in efforts to produce modest yet effective swimwear and sportswear for Muslims.

THE FASHION SYSTEM

The fashion industry forms part of a larger social and cultural phenomenon known as the "fashion system," a concept that embraces not only the business of fashion but also the art and craft of fashion, and not only production but also consumption. The fashion designer is an important factor, but so also is the individual consumer who chooses, buys, and wears clothes, as well as the language and imagery that contribute to how consumers think about fashion. The fashion system involves all the factors that are involved in the entire process of fashion change. Some factors are intrinsic to fashion, which involves variation for the sake of novelty (e.g., when hemlines have been low for a while, they will rise). Other factors are external (e.g., major historical events such as wars, revolutions, economic booms or busts, and the feminist movement). Individual trendsetters (e.g., Madonna and Diana, princess of Wales) also play a role, as do changes in lifestyle (e.g., new sports, as when skateboarding was introduced in the 1960s) and music (e.g., rock and roll, hip-hop). Fashion is a complex social phenomenon, involving sometimes conflicting motives, such as creating an individual identity and being part of a group, emulating fashion leaders and rebelling against conformity. The fashion industry thrives by being diverse and flexible enough to gratify any consumer's desire to embrace or even to reject fashion ability, however that term might be defined.

In comparison, the simultaneous de-sign approach, inspired by the practice of Delaunay, deals with both the garment's form and surface (textile) at the same time. As such, the two aspects are mutually dependent on each other and have to be developed alongside. For example, the development of technology has allowed for the development of engineered digital print, designed within the form's constraint (Fogg, 2006). Designers like Mary Katrantzou and Peter Pilotto are known for their mastery of working with digital engineered prints. "It is about trying to do with print, what a black dress does," Katrantzou says about her way of working (Katrantzou in Muller, 2012). Digital technology allows for the print to take on a more significant role within the garment's design process. However, the connection between printing) and garment's form remains that of one informing the other.

FASHION WEEK BACKSTAGE ROLES

THE PRODUCTION TEAM

Many times, designers will hire a production company to create their vision and piece together every single aspect of the show. The producer is the person/team who works closest to the designer, ensuring that every decision made reflects the brand's aesthetic and the vision of the show. They are the glue that holds the entire event together and usually are in charge of overseeing every detail down to the lighting, sound and even the color of the benches guests will sit on.

Behind the scenes on the day of the show, the producer will oversee model timings, choreography, music and lighting. The production team is also in charge of setup and breakdown, knows the show space the best and therefore is usually the team you will see wearing headsets and controlling traffic backstage during the madness. If you've ever worked backstage during Fashion Week, you'll know that they are the people you go to with a question and also the ones you clear the way for anytime you see them running (they are always running!).

THE PR TEAM

Depending on the size of the brand, the Public Relations team may have different roles before, during and after a show presented during Fashion Week.

Some of the most important responsibilities a publicist has include: inviting press for show day coverage, managing editors backstage, arranging seating charts, overseeing RSVP lists and communicating needs for VIP accommodations and green room interviews. They are the keepers of "the guest list" and have the power to admit or turn away anyone at the door.

Some PR teams are known to work closer to designers on the actual layout, production and timeline of the show while others are in-house teams that know the brand aesthetic and can easily relay the narrative for the season's collection statement to the press.

STYLISTS + COLLECTION COORDINATORS + MODEL DRESSERS

While these roles don't fall under the same team, they do work together very closely behind the scenes and are vital to the success of the show.

Stylists are usually hired in-house by the brand and/or designer and will often have their own small team with one main stylist that is in charge of the rest. They work hand in hand with the designer long before Fashion Week to select the looks – from clothing down to shoes, jewelry and any additional accessories.

Many images are taken and a board, known as the Run of Show, is created with each look numbered and listed in various areas backstage. Once final looks are selected, the Collection Coordinators create small, individual boards – one per look. On each board, they list out every single item the model will wear for the look, specific styling instructions and any additional notes. These mini boards are placed strategically on racks with their corresponding looks backstage for dressers to reference when dressing their model.

Model dressers are oftentimes volunteers whose only responsibility is making sure the model(s) they are assigned are ready with their looks during the show. A dresser could sometimes be assigned multiple models to dress or have 1 model with multiple looks, called quick changes. Usually, these responsibilities go to seasoned dressers who can handle the speed and demands this role can have.

HAIR & MAKEUP (HMU)

No fashion show can go on without the incredible work of the hair and makeup teams. Similar to all the others, these teams also have a lead and various assistants for each area of work. By working closely with the designer and lead stylist, hair and makeup teams are able to create the show's overall visual aesthetic that is cohesive with the collection.

Various rounds of tests are done in the days leading up to the show, sometimes even on the day of. From there, the leads create a similar board of information that breaks down all the details for the stylists that will be working on models backstage the day of the show. The types of styles and colors used can be outrageous and time consuming, making the stylists' jobs stressful if models arrive later than scheduled due to delays from other shows they're coming from.

Designers like the late Alexander McQueen were notorious for using hair and makeup as an integral part of the show and an unmistakable element in the fantasy he produced season after season.

COMMUNICATION PERSPECTIVE OF THE FASHION SHOW

A Fashion Show is first and foremost a show. "Designer shows that fall into the category of spectacle are closely connected to the performing arts of theatre and opera, as well as feature films and music videos. As with stage performances, shows created by spectacle designers feature far more than garments. In most cases, they read as mini dramas, complete with characters, specific locations, related musical scores, and recognizable themes. Often, the only element setting fashion shows apart from their theatrical counterparts is their fundamental purpose—to function as a marketing ploy" [1, p. 246].

Shows have an entertainment function that can reinforce the idea of fashion beyond a simple information transmission function, i.e. an eventful character that can attract the attention of the audience [16]. Nowadays, fashion shows are used as a central tool of communication, emphasizing the visual and performance aspects of modern media. The actual fashion shows exclusivity must not be preserved but can be used as a marketing tactic. Furthermore, the installations do not simply illustrate that these fashion companies are digital innovators but promote the use of media efforts on its own sake [17]. When analyzing and developing a fashion show, it is important not to forget the elements related to marketing and communication strategy. Therefore, the constancy and continuity of fashion shows every season work to consolidate the brand and position it in the market.

As mentioned above, in a fashion show there is no clear limit between what is fashion and what is art. All the elements that a fashion designer uses, such as popular culture or historical precedent, promote the integration of fashion and performance [1]. There are four main elements that all designers can work with in order to make a unique show: model, location, theme and finale. The Spectacle effect can be added to these four, with other implicit elements such as music and lighting.

MODEL

There are many types of models in the fashion industry and they can be used for different purposes. For each Fashion Show the brands try to choose the right ones for the project. We can find: Runway models, Fit models, Glamour models, plus-size models or Alternative models. When the brands work with the models they have to take into account if they work with agencies or representatives, if an exclusivity contract is desired or what is the licence fee.

Some researchers point to Gianni Versace as the person responsible for the rise of the supermodel, which gave rise to the association with celebrities especially during the late 1980s and early 1990s. The model possesses a leading role in the show where the subject is not only a mere wearer of the garments as an object of expression but also shoes, accessories and branding. In addition, they play the role of showing the costume through their actions and movements on stage. Therefore, at the communication level, the models are also a key element to create attraction towards the event, to generate news and virality.

LOCATION

Beyond seeking novelty through unconventional models, designers also experiment with the location of their shows. The stage where a show takes place is of great importance for the designer and the brand. The shows associated with the official fashion week calendars are located mainly in: Paris, Milan, London, and New York. Each brand searches within these cities for the best place in relation to the inspiration of the collection, the media power or allowing a wide audience. Brands also organise shows outside of the fashion week circuit shows, known as cruise collections or ‘destination fashion shows’. In these runways, the location is an essential element to attract the media. “Sometimes the location is related to national or regional origins of a label and are often centred on mythical fashion cities” [15, p. 9]. Many cities present a symbolic capital that helps shape the Storytelling of a brand or a collection [15]. “In the case of the runway shows, concentrating on the house’s geographical origins is not the only way to create added value for a fashion brand. Increasingly, in addition to the birthplace of the house, other more exotic locations are used as fantasy projections and mythological reference points”

THEME

The theme of the show is the source of inspiration for the designer, the theme can be specific or abstract. The theme is an essential element in communication and marketing as it not only determines what the collection will look like, but also its communication, from the press conference and invitations to all the production of communication and sales materials, such as events associated with the shows. The theme will be the hook for all audiences: experts, media and consumers. As Evans (1999) explains, one of the first designers who gave great importance to the theme was Elsa Schiaparelli, who gave each collection a theme, two of them very renowned, inspired by the Circus Collection and the Commedia dell’arte [19]. Other great renowned designers were also highlighted by the themes of their shows such as Alexander McQueen, John Galliano or Karl Lagarfeld. The theme is associated with “StoryTelling”, which is the technique of telling stories through Fashion Shows. Sung & Know [9] explain that it is an essential element to transmit the brand and the history of the show and that it can be described as: “Story” = Fashion Design; “Telling” = Show. In other words, every Fashion Show must have and be a Storytelling, since people associate fashion design with the substance of a story, a show with the way of telling and a fashion show with the storytelling.

FINALE

For Duggan [1] all shows, and therefore also fashion shows, have to pay special attention to how the event ends. This is one of the points where the Fashion Shows come more in connection with other arts such as theatre. The finales have to be designed to produce a great impact on the attendees that makes that show memorable and also generates conversations and news. The conclusion and the tone of the end of the show become determining factors for the audience, where the designer's creative idea is reflected.

SPECTACLE

Fashion designers or Creative Directors tend to turn their Fashion Shows into big spectacles. For this purpose they usually focus on specific themes, create large stages, take care of the lighting, music, and staging. They seek to produce visually impressive performances tied to a particular theme, time, and place [1]. Sometimes, fashion shows also feature great choreography that tries to effectively showcase the theme of the fashion show and make an impact on the audience. In fashion shows, choreography also involves how the models walk and their facial expressions, enhancing the image of the show [9]. In this paper we associate to the Spectacle variable all the elements related to the experience of the audience in the Show. Fashion shows are a form of multisensory stimulation

IN THE END, the production of a fashion show, especially during Fashion Week, takes an enormous amount of organization, flexibility and teamwork to successfully execute. Every single person that is working behind the scenes has a job to do and is essential in the hierarchy of responsibilities – from producers to runners to volunteers.

CONCLUSION

After the analysis of the show, we can affirm that the four variables proposed in this study are adequate in evaluating the communication of a fashion show. The collection reproduced a revolutionary encounter between the African craftsmanship of Rousteing's roots and the essence of the European culture that permeated his life.

Without losing its emphasis on novelty and spectacle, the show became a walking identity of its creative director, where through insignificant details and spectacular events he fused reality, fiction, and idealization. It should be noted that the importance of a fashion show is not just each individual collection, but instead, it's that special feeling that continues even after a show ends, such as what happened in the case of the Balmain fashion show.

The digital show was the other big show that the brand showcased through its various social channels. The panorama of new technologies is not alien to the world of fashion but is part of it, including behind the scenes of the show. Growing the impact and what is more important, the expectation towards the collection. Balmain's most relevant social networks and platforms, such as YouTube, Instagram and TikTok, showed the Festival live to their community [33].

The fashion industry is known for changing the status quo and an example of this was the creation of the new launch in three-dimensional format [31]. Through the maison's social networks, following a content planning and a very careful aesthetic, the brand was revealing different details of what happened in the big show, dividing the show experience into: pre-show, show and post-show.

The proposal of analysis based on the four elements validates their importance in the fashion shows and opens a path to future research. Given the proliferation of brands that want to make fashion shows as a communication tool, or the ability to perform in a more democratic way with the digital shows, it could be interesting to systematically analyze those elements that make the Fashion Show a unique communication or marketing action. Fashion Shows can not only be a moment where the new collections are shown. For the creation of brand experience for the followers and buyers of the brand, it is relevant also to highlight the elements that make this event unique.

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EVALUATING PHYSICAL PROPERTIES: INSIGHTS INTO NATURAL AND LYOCELL FABRICS

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ABSTRACT

This study investigates the mechanical performance of cotton-blended fabrics and Lyocell fabrics by comparing their bursting strength and tearing strength under standardized testing conditions. Cotton-blended fabrics, known for their softness and breathability, were evaluated alongside Lyocell, a regenerated cellulose fiber celebrated for its sustainability and durability. The analysis revealed that Lyocell fabrics exhibited superior bursting strength due to their uniform fiber structure, while cotton blends demonstrated higher tearing strength, likely attributable to the unique interplay between cotton and synthetic fibers. These findings highlight the trade-offs between these fabric types in terms of mechanical properties and their suitability for diverse applications. The study provides valuable insights for textile manufacturers and designers seeking to optimize material selection for durability and sustainability in fabric production.

Keywords: Natural fabrics, Lyocell fabrics, Bursting strength and Tearing strength

INTRODUCTION

In order to improve their mechanical and physical qualities, cotton is combined with other natural, synthetic, or semi-synthetic fibers to make cotton-blended textiles. Cotton may be blended with polyester, rayon, or spandex to create textiles that are more durable, wrinkle-resistant, and elastic while yet retaining the softness, breathability, and moisture absorption of cotton. Because of their adaptability and capacity to satisfy certain performance standards, these textiles are extensively utilized in the fashion, home furnishings, and industrial sectors (Smith, 2021). Additionally, by lowering the dependency on just natural resources, combining fibers can maximize sustainability and manufacturing costs (Jones & Miller, 2020).

The cellulose used to make Lyocell, a sustainable semi-synthetic fiber, is mostly obtained from wood pulp, which includes spruce, beech, and eucalyptus trees. Lyocell, which was created as a sustainable substitute for conventional textiles, is made in a closed-loop method with organic solvents such as N-methylmorpholine N-oxide (NMMO), which are nearly always recovered and recycled. When compared to traditional rayon or viscose, this production process has a lower environmental effect (Bharat et al., 2019). The softness, breathability, and moisture-wicking qualities of lyocell fabrics make them renowned for use in everything from household textiles to clothing. Additionally, they have outstanding strength, durability, and biodegradability, which increases their allure in the expanding market for eco-friendly materials and sustainable design (Smith & Taylor, 2020).

A crucial mechanical characteristic of textiles is their bursting strength, which gauges how long they can tolerate pressure or force applied perpendicular to their surface before rupturing.

This factor is especially important for textiles used in sportswear, upholstery, and technical textiles—applications that demand resilience to wear and durability. The fiber type, yarn characteristics, finishing treatments, and the weave or knit structure of the fabric all affect the bursting strength (Das & Mukhopadhyay, 2012). In order to ensure consistency and dependability when assessing a fabric's performance under multidirectional stress, it is frequently evaluated using techniques like the hydraulic or pneumatic bursting strength test (ASTM D3786/D3786M, 2020). Designing textiles that satisfy certain functional and safety needs requires an understanding of and commitment to maximizing this attribute.

One of the most important characteristics of textiles is their ripping strength, which measures how resistant they are to tearing under focused power. It is especially important for materials like industrial textiles, outdoor gear, and protective apparel that are subjected to extreme weather or high levels of stress. Fiber type, yarn structure, weave or knit pattern, and fabric finishing procedures are the main determinants of tearing strength (Mukhopadhyay & Midha, 2015). To assess tearing strength under controlled circumstances, testing techniques such as the Elmendorf tear test and the trapezoidal tear test are frequently employed (ASTM D1424-20, 2020). In many textile applications, where resistance to wear and tear is crucial, increasing tearing strength is crucial to guaranteeing performance and durability.

Materials and Methods

Cotton blended fabrics & Lyocell fabrics are the two fabrics used for the study. This is a comparative study made to analyze the better bursting strength and tearing strength present among the two fabrics.

Bursting Strength tester (Kg/cm^2)

To analyze the bursting strength of the selected fabrics digital bursting strength tester is used here. The fabrics were kept in between the two clamps and the hydraulic pressure were used to inflate a rubber diaphragm, which expands against the sample stretching it. Five readings were noted for each sample, from which the better bursting property is evaluated. The below table 01 denotes bursting strength (kg/cm$^{2)}$ of cotton blended and lyocell fabrics.

S.No	Fabric types	
	Cotton blended fabric	Lyocell fabric
1.	9	8
2.	8	9
3.	8	9
4.	9	9
5.	8	9

Table 01- Bursting strength of cotton blended and lyocell fabrics

Figure 01 – Bursting Strength Tester

Tearing Strength tester (Kg/cm^2)

To analyze the tearing strength of the selected fabrics, 1"X2" size fabric was cut and places in between the clamps, the tear strength is measured by the force needed to tear the fabric. Five readings were noted for each sample, from which the better tear property is evaluated. The below table 02 denotes tearing strength (kg/cm$^{2)}$ of cotton blended and lyocell fabrics.

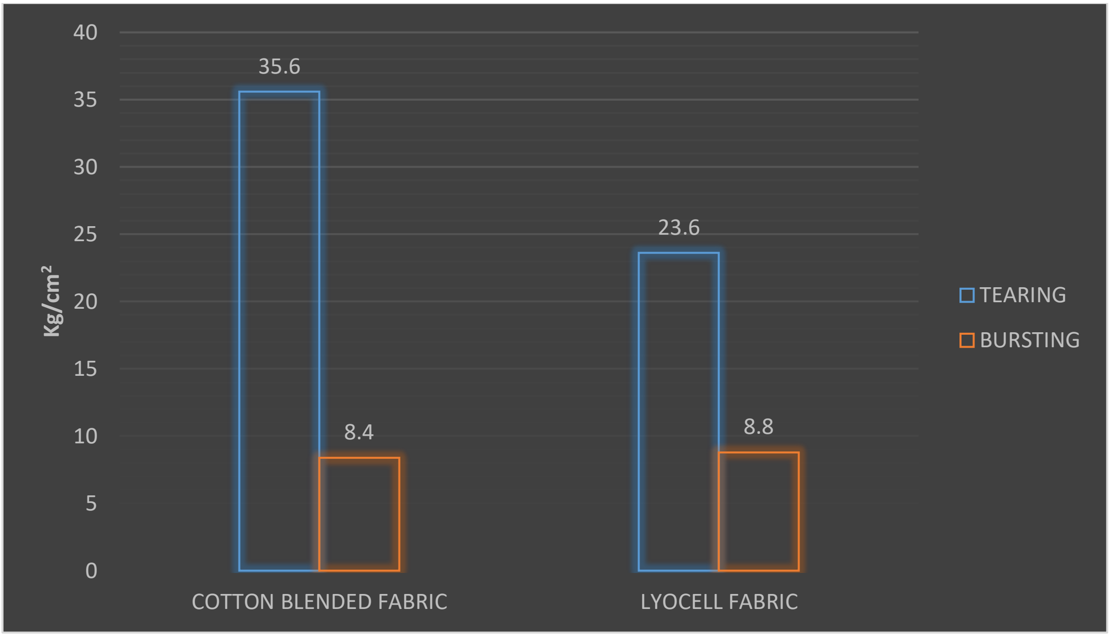
S.No	Fabric types	
	Cotton blended fabric	**Lyocell fabric**
1.	36	25
2.	37	22
3.	34	24
4.	35	25
5.	36	22

Table 02- Tearing strength of cotton blended and lyocell fabrics

Figure 02 – Tearing Strength Tester

Results and Discussions

The selected fabrics cotton blend and lyocell fabric, were taken under evaluation from the values of each sample for tearing strength and bursting strength. The below graph represents the average values of the readings taken.



From the above graph it is concluded that cotton blended fabrics has got the higher tearing and bursting strength property than lyocell fabrics, how ever lyocell fabric are sustainable and are greater alternative for other non degradable fabrics, the physical properties of cotton blended fabrics remain higher.

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LEVERAGING AI FOR PREDICTIVE CONSUMER BEHAVIOUR IN FASHION: UNLOCKING TRENDS AND PERSONALIZING EXPERIENCES

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ABSTRACT

The integration of Artificial Intelligence into the fashion industry has revolutionized how consumer preferences are understood and leveraged. AI-driven tools analyse vast datasets from social media, e-commerce platforms, and customer interactions to extract actionable insights. These technologies enable brands to anticipate emerging trends, personalize shopping experiences, and adapt to shifting market demands with unprecedented accuracy. Sentiment analysis, a cornerstone of AI in consumer insights, deciphers customer emotions and opinions about fashion products, helping brands align their offerings with consumer desires. Furthermore, AI reveals generational and cultural variations in purchasing behaviours, allowing for targeted marketing strategies and inclusive design practices. By harnessing AI for consumer insights, the fashion industry not only enhances customer satisfaction but also improves inventory management, reduces waste, and strengthens brand loyalty in an increasingly competitive and fast-paced market.

Keywords: Artificial Intelligence, Consumer Insights, Fashion Industry, Shopping Experience, Consumer Preferences.

1.INTRODUCTION

The fashion industry, characterized by its fast-paced and ever-evolving nature, faces constant challenges in predicting and meeting consumer expectations. With the advent of Artificial Intelligence, brands and retailers now have powerful tools to gain deep insights into consumer behaviour, preferences, and emerging trends. AI-driven consumer insights leverage vast amounts of data from diverse sources such as social media, e-commerce platforms, and point-of-sale systems to provide a nuanced understanding of market dynamics.

By analysing this data, AI uncovers patterns and sentiments that traditional methods often overlook, enabling brands to make informed decisions about product development, marketing strategies, and customer engagement. Technologies such as machine learning, natural language processing, and sentiment analysis play a pivotal role in deciphering consumer feedback and predicting future demands.

The fashion industry continues to integrate AI into its operations, understanding how to effectively harness these insights becomes crucial for maintaining competitiveness and relevance in a rapidly changing market landscape.

2. Artificial Intelligence in AI-Driven Consumer Insights in Fashion

Artificial Intelligence serves as the cornerstone for transforming raw data into actionable consumer insights in the fashion industry. Through advanced algorithms and machine learning models, AI processes large-scale data from diverse sources, including social media platforms, online reviews, and shopping behaviours. These insights empower fashion brands to stay ahead of trends, anticipate consumer preferences, and tailor their offerings to specific target audiences.

2.1 Machine Learning:

Machine Learning algorithms identify patterns in consumer behaviour, such as purchasing habits, seasonal preferences, and loyalty trends. By continuously learning from new data, ML models improve predictions over time, ensuring brands stay aligned with dynamic market demands.

2.2 Natural Language Processing:

Natural Language Processing enables the analysis of textual data, such as customer reviews, feedback, and social media posts. This technology interprets sentiment, tone, and key themes, providing valuable context to consumer opinions about fashion products and services.

2.3 Predictive Analytics:

Predictive models utilize historical data and real-time inputs to forecast future consumer behaviours and trends. These insights help brands design collections, optimize pricing strategies, and plan inventory with precision.

2.4 Computer Vision:

AI-powered computer vision applications analyse visual content from platforms like Instagram and Pinterest. By recognizing patterns in shared images, such as trending colours, styles, or fabrics, fashion brands gain insights into current aesthetic preferences.

2.5 Recommendation Systems:

AI-driven recommendation engines enhance personalization by suggesting products based on individual consumer behaviour. This creates a seamless shopping experience, increasing customer satisfaction and driving sales.

3. Consumer Insights in Fashion: The Role of AI

Consumer insights are the actionable understandings of customer behaviours, preferences, and expectations that drive business decisions. In the context of the fashion industry, these insights are crucial for designing collections, tailoring marketing strategies, and enhancing customer experiences. The incorporation of Artificial Intelligence (AI) has revolutionized how these insights are gathered, analysed, and applied.

1.1 Data Collection and Integration:

Platforms like Instagram, TikTok, and Twitter reveal trending styles, hashtags, and influencer-led movements. Shopping patterns, search queries, and purchase histories provide insights into consumer preferences. Online reviews and surveys offer direct insights into customer satisfaction and expectations.

1.2 Trend Prediction:

AI-driven trend analysis uses real-time data to forecast future consumer demands. For instance, it can predict the rising popularity of certain fabrics, colors, or silhouettes based on emerging social media discussions and sales data.

1.3 Market Segmentation:

AI clusters consumers into precise segments based on demographics, purchase history, and lifestyle preferences. This helps brands develop targeted strategies and cater to niche markets effectively.

1.4 Sustainability Preferences:

The increasing emphasis on sustainability, consumer insights help brands identify and address environmental and ethical concerns of their target audience, driving loyalty among eco-conscious shoppers.

3.5 Impact of AI-Driven Consumer Insights

AI has redefined the way fashion brands connect with their audience. Improve product offerings that resonate with current market trends. Minimize overproduction and waste by aligning supply with demand. Enhance customer satisfaction through personalized experiences.

4. Fashion Industry:

The fashion industry operates in a fast-paced environment where understanding consumer preferences is critical for success. With shifting trends, growing competition, and increasing demand for personalization, AI-driven consumer insights have become a vital tool for fashion brands to stay ahead. By integrating AI into their operations, brands can gain a competitive edge, streamline processes, and enhance their market positioning.

4.1 Challenges in the Traditional Fashion Industry

Consumer preferences and fashion trends change rapidly, making it difficult to predict what will resonate with audiences. The influx of consumer data from social media, e-commerce, and retail transactions often overwhelmed traditional analytical methods. A lack of accurate demand forecasting led to overproduction or stock shortages, resulting in financial losses and waste. Without detailed insights, marketing efforts often failed to resonate with diverse consumer segments.

4.2 The Role of AI in Revolutionizing the Fashion Industry

4.2.1 Predict Trends with Precision:

AI algorithms analyse vast datasets from social media platforms, online searches, and influencer activities to identify emerging trends. This allows brands to align their collections with what consumers are likely to embrace next.

4.2.2 Enhance Customer Personalization:

Recommending products based on individual preferences. Offering tailored discounts and promotions. Curating collections that resonate with specific audience segments.

4.2.3 Optimize Supply Chain Management:

Forecast inventory needs accurately. Reduce overproduction and minimize waste. Streamline logistics for faster delivery times.

4.2.4 Strengthen Brand-Consumer Relationships:

AI-driven sentiment analysis provides insights into how consumers perceive a brand. This enables companies to adapt their messaging, improve customer service, and foster loyalty.

4.2.5 Promote Sustainability:

AI insights guide the development of eco-friendly products and practices, aligning with the increasing demand for sustainable fashion. Brands can identify consumer segments prioritizing ethical choices and tailor their offerings accordingly.

5. Shopping Experience:

The shopping experience is a critical touchpoint for consumer satisfaction in the fashion industry. Artificial Intelligence plays a transformative role in reshaping how customers discover, engage with, and purchase fashion products. By leveraging consumer insights, AI enables brands to create seamless, personalized, and efficient shopping experiences both online and in physical stores.

5.1 Personalized Recommendations:

AI algorithms analyse individual shopping behaviours, preferences, and past purchases to suggest items tailored to each customer's style. Dynamic recommendation engines improve cross-selling and upselling by presenting complementary products.

5.2 Virtual Try-Ons and Augmented Reality:

Virtual fitting rooms powered by AI and AR let customers visualize how clothes will look and fit without needing a physical try-on. This reduces return rates and enhances confidence in online shopping.

5.3 Chatbots and Virtual Assistants:

AI-powered chatbots provide real-time customer support, helping shoppers find products, answer queries, and complete purchases. These tools are available 24x7, ensuring uninterrupted service and improved convenience.

5.4 Smart Search Features:

Visual search allows shoppers to upload images and find similar products, making it easier to locate desired styles.AI-driven search tools refine results based on user preferences, enabling faster and more accurate product discovery.

5.5 Dynamic Pricing and Offers:

AI analyses market trends and customer data to optimize pricing strategies. Personalized discounts and promotions are sent to customers based on their shopping history and loyalty levels.

5.6 Benefits of AI-Driven Shopping Experiences

Tailored experiences meet individual needs and expectations. Personalized recommendations and efficient interfaces reduce decision fatigue and encourage purchases. Virtual try-ons and accurate sizing tools help customers choose items that meet their expectations. Consistently positive experiences foster deeper connections with customers.

6. Consumer Preferences:

Consumer preferences in the fashion industry are constantly evolving, shaped by cultural shifts, technological innovations, and individual desires. Understanding these preferences is crucial for fashion brands looking to stay relevant and meet customer expectations. AI-driven consumer insights are transforming the way brands analyse and respond to consumer behaviour, enabling them to offer highly personalized experiences and more accurate product offerings.

6.1 Behavioural Data Analysis:

AI tools analyse vast amounts of consumer data from online interactions, purchase histories, and browsing behaviours. By identifying patterns and preferences, AI models can predict what consumers are likely to purchase in the future. This data-driven approach allows brands to offer products that resonate with their target audiences.

6.2 Sentiment Analysis:

AI-powered sentiment analysis processes data from social media, online reviews, and customer feedback to gauge the emotional tone of consumer opinions. This helps brands understand how their products are perceived and identify areas for improvement. By recognizing positive or negative sentiments around certain trends or products, fashion brands can tailor their collections to match consumer emotions and desires.

6.3 Personalization of Product Offerings:

AI enables deep personalization by analyzing consumers' past purchase behaviors and preferences. Based on this data, AI can suggest styles, colors, or items that align with individual tastes. For example, if a consumer frequently purchases sustainable brands, AI algorithms may prioritize eco-friendly product recommendations.

6.4 Trend Prediction:

By aggregating data from multiple sources—such as social media, fashion blogs, and consumer interactions—AI can predict which styles, fabrics, or colors are gaining popularity. This helps brands align their collections with shifting consumer preferences and proactively address upcoming fashion trends.

6.5 Cultural and Regional Differences:

AI allows brands to tailor their offerings based on cultural and regional preferences. By segmenting consumers according to location, AI-driven insights can provide nuanced recommendations that consider local fashion trends, seasonal preferences, and cultural aesthetics.

6.6 Price Sensitivity:

AI models also analyse price sensitivity, helping brands understand how much consumers are willing to spend on various fashion items. By adjusting pricing strategies based on these insights, brands can cater to different consumer segments and maximize revenue.

6.7 Sustainability Preferences:

With growing consumer interest in ethical fashion, AI helps brands identify customers who prioritize sustainability. AI tools can analyse consumers' values and behaviour to promote eco-friendly products, such as those made from recycled materials or produced with ethical labour practices.

6.8 Impact of AI on Consumer Preferences in Fashion

6.8.1 Enhanced Customer Engagement:

AI allows brands to engage with consumers on a deeper level, offering personalized recommendations and creating targeted advertising campaigns. Consumers are more likely to engage with brands that understand their specific needs and preferences, leading to stronger customer relationships.

6.8.2 Improved Product Development:

By leveraging AI-driven insights, fashion brands can develop products that are more aligned with consumer preferences, reducing the risk of unsold inventory and enhancing product appeal.

6.8.3 Faster Response to Changing Trends:

AI's ability to predict and track consumer preferences in real-time ensures that fashion brands can quickly adapt to changing trends, staying ahead of competitors and meeting consumer demands efficiently.

6.8.4 Efficient Marketing Campaigns:

AI enables brands to create targeted marketing campaigns that resonate with specific consumer segments. By analysing preferences and behaviour, AI helps brands determine the most effective messaging and channels for reaching their audience.

CONCLUSION:

The integration of Artificial Intelligence in the fashion industry has fundamentally transformed how brands understand and cater to consumer preferences. AI-powered tools provide an in-depth analysis of consumer behavior, from real-time trend forecasting and sentiment analysis to personalized product recommendations. By harnessing vast amounts of data from multiple touchpoints, AI enables fashion brands to predict consumer demands with remarkable accuracy, deliver tailored shopping experiences, and optimize inventory management. As consumer preferences continue to evolve rapidly, AI offers the agility and precision needed for brands to stay ahead of the curve. It not only helps in identifying emerging trends but also allows brands to personalize offerings, improve customer engagement, and respond dynamically to shifting market conditions. The growing importance of sustainability in consumer choices further underscores AI's role in enabling eco-conscious fashion solutions. Looking ahead, AI's role in the fashion industry will only expand. The future promises even deeper integration of AI with emerging technologies such as voice-activated shopping, emotional AI, and hyper-customized products. With AI continuing to enhance consumer insights, fashion brands are better positioned to meet the demands of an increasingly diverse and sophisticated global consumer base, driving innovation and fostering deeper brand loyalty. In conclusion, AI-driven consumer insights are no longer just an advantage in the fashion industry—they are essential for brands seeking to thrive in an increasingly competitive and fast-paced market. By leveraging AI, fashion companies can unlock new opportunities for growth, deliver exceptional customer experiences, and shape the future of fashion.

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A REVIEW ON ANTI-ODOUR FINISHING PROPERTIES OF TEXTILES

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ABSTRACT:

Odour in textiles typically results from the accumulation of sweat, bacteria, and other organic compounds. These compounds cause unpleasant smells and reduce garments' lifespan and usability. Managing these odours is a complex and multifaceted challenge that has gained increasing attention in recent years. Whether in everyday clothing, sportswear, or specialized applications like medical textiles, the ability to control odour is crucial not only for comfort but also for health and social well-being. Odourless or odour-resistant fabrics have an antimicrobial component designed to eliminate bacteria growth before it mixes with sweat to create odour. Textiles protect our human body against external factors. These textiles are not sterile and can harbor high bacterial counts as sweat and bacteria are transmitted from the skin. People look for cloth, which smells good and remain refreshing for longer time, thereby thriving their self-esteem. Therefore, in recent years most people ardent to wear the finished cloth that can reduce the body odour. This finish is called anti-odour or novel finish. Future developments may focus on using natural and biodegradable materials for odour absorption and elimination, reducing reliance on synthetic chemicals and enhancing the environmental sustainability of these products. As demand for sustainable and eco-friendly products continues to grow, there is significant potential for innovation in odour-controlling textiles. This articles mainly aims to discuss about the odour resistance properties on textiles using different extracts.

Keywords: Odour resistant, sustainability, natural extracts, eco-friendly products

1. INTRODUCTION

Textile fibers in clothing and interior products act as a reservoir for the sorption of many organic volatile and semi-volatile organic compounds in the indoor environment. Furthermore, due to the close contact of clothing next to the body, sweat, sebum and bacteria can transfer to the textile fibers and yarns. The sorption and subsequent release of odorous volatile organic compounds (VOCs) present in human sweat within apparel fibers/yarns can cause an unpleasant experience for end users. The problem can be exacerbated if odorants, or the source of odors, are not completely removed during laundering. Odour in textiles typically results from the accumulation of sweat, bacteria, and other organic compounds. These compounds cause unpleasant smells and reduce garments' lifespan and usability. Managing these odours is a complex and multifaceted challenge that has gained increasing attention recently. Whether in everyday clothing, sportswear, or specialized applications like medical textiles, the ability to control odour is crucial not only for comfort but also for health and social well-being. Understanding how odors are generated, retained and released from textiles is vital to addressing this important consumer issue. Attending to the problem of odour in textiles has broader implications for the longevity of clothing, and facilitating textile reuse, which is essential for a circular economy.

2. REVIEW OF LITERATURE

2.1 Natural Fibres in Odour Absorption

Certain natural fibres also possess inherent odour-absorbing properties. Wool, for instance, is known for its ability to absorb moisture and trap odour molecules within its complex protein structure. The keratin in wool interacts with odour-causing compounds, reducing their volatility and making them less detectable.

Wool's odour-absorbing properties make it an excellent choice for garments worn close to the skin, such as socks and base layers. Unlike synthetic fibres, which can sometimes retain odours even after washing, wool's natural ability to absorb and neutralise odours helps keep garments fresh for longer periods.

2.2Eliminating Odours: Chemical and Biological Approaches

2.2.1Antimicrobial Agents

Eliminating odours can be achieved by chemically breaking down the molecules responsible for the smell or preventing their formation. One of the most effective methods is the use of antimicrobial agents in textiles.

Bacteria are often the primary source of odour, particularly in textiles that come into contact with sweat. While sweat is initially odourless, bacteria on the skin and in the fabric metabolise it, producing odorous compounds as by-products.

Antimicrobial agents like silver ions are widely used in odour-control textiles due to their ability to inhibit bacterial growth. Silver ions disrupt bacterial cellular processes, preventing them from multiplying and producing odour. This not only eliminates existing odour but also reduces the likelihood of future odours developing.

Other antimicrobial agents used in textiles include copper, zinc, and triclosan. These agents are incorporated into the fabric during manufacturing, either through coating, embedding, or blending with the fibres.

2.2.2Photocatalytic Materials

Another approach to eliminating odours is the use of photocatalytic materials like titanium dioxide (TiO2). When exposed to light, particularly ultraviolet (UV) light, TiO2 generates reactive oxygen species (ROS) such as hydroxyl radicals. These ROS are highly reactive and can break down organic compounds, including odour-causing molecules.

Photocatalytic materials are particularly useful in applications where textiles are exposed to sunlight, such as outdoor clothing or curtains. The self-cleaning properties of these materials help maintain fabric freshness without the need for frequent washing.

2.2.3Enzymatic Degradation

Enzymes offer another promising method for odour elimination in textiles. As biological catalysts, enzymes can break down specific compounds, including those responsible for odours. For instance, protease enzymes degrade proteins in sweat, reducing the nutrients available for bacteria and thereby preventing odour formation.

Enzyme-based treatments are typically applied to textiles during the finishing process. These treatments can be tailored to target specific types of odours, making them highly versatile. However, the stability and longevity of enzyme treatments in textiles are still areas of ongoing research, as enzymes can be sensitive to environmental conditions such as temperature and pH.

2.2.4 Limitations of Odour-Eliminating Approaches

While odour-eliminating approaches are effective, they come with certain limitations. The use of antimicrobial agents, for example, raises concerns about the potential development of antibioticresistant bacteria, leading to increased scrutiny and regulation of antimicrobial treatments in textiles.

Photocatalytic materials, although effective in breaking down odour molecules, require exposure to light to function. This limits their effectiveness in indoor environments or in garments not frequently exposed to sunlight.

Enzymatic treatments may degrade over time, particularly after repeated washing, which can reduce their effectiveness. This may necessitate re-treatment of the textiles, adding to the maintenance burden.

2.3Natural extracts

2.3.1Citrus Peels: Citrus essential oils Grapefruit oil and lemon extracts have been suggested as effective natural anti-oxidative compounds.

2.3.2 Calamus: Calamus root, also known as sweet flag, has a long history of use in traditional medicine. Some people claim that it can be used to control body odor,

Calamus root contains a compound called beta-asarone, which has a strong, pungent odor. Some people believe that this odor can mask body odor. However, the calamus root is effective at controlling body odor.

2.4 Applications of Odour- Controlling Textiles

2.4.1 Sportswear and Active wear

One of the most significant applications of odour-controlling textiles is in sportswear and active wear. Athletes and fitness enthusiasts require clothing that can keep them comfortable and fresh during intense physical activity. Odour-control technologies, such as antimicrobial treatments and moisture-wicking fabrics, are commonly used in this category to enhance performance and comfort.

2.4.2 Medical Textiles

In the medical field, odour control is crucial for maintaining hygiene and patient comfort. Textiles used in hospital settings—such as bed linens, patient gowns, and wound dressings—are often treated with antimicrobial agents to prevent the growth of bacteria and reduce the risk of infections. Odour-controlling textiles also improve the quality of life for patients with chronic conditions that cause excessive sweating or odour.

2.4.3 Home Textiles

Odour-controlling technologies are also being integrated into home textiles, such as bed linens, towels, and upholstery fabrics. These products benefit from the inclusion of odour-absorbing and eliminating materials, helping to maintain a fresh and pleasant environment in the home. Scented textiles are also popular in this category, offering the dual benefits of odour control and aromatherapy.

2.4.4 Military and Outdoor Gear

In military and outdoor applications, odour control is not just a matter of comfort but also critical for operational effectiveness. Soldiers and outdoor enthusiasts often spend extended periods in harsh environments with limited access to washing facilities. Odour-controlling textiles help maintain hygiene, reduce the risk of skin infections, and provide a psychological boost by keeping clothing fresh and comfortable.

3. CONCLUSION

The management of odour in textiles is a rapidly evolving field, driven by advances in material science, biotechnology, and smart technology. Various strategies, including absorption, elimination, masking, and washing, are employed to tackle the challenge of odour in textiles. Each approach offers unique benefits and limitations, making them suitable for different applications and user needs.

As technology continues to advance, the future of odour-controlling textiles looks promising. Innovations in sustainable materials, biotechnology, and smart textiles are poised to revolutionise the way odour is managed in clothing and other textile products. However, challenges related to durability, performance, and environmental impact must be carefully addressed to ensure that these innovations lead to practical, effective, and eco-friendly solutions.

4. ACKNOWLEDGEMENT

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ANALYSIS OF MOISTURE MANAGEMENT PROPERTIES OF SOCKS MADE OF COTTON AND COTTON/BAMBOO YARNS

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ABSTRACT:

Socks are designed to deliver optimal comfort and performance, with material selection playing a key role in their effectiveness. Moisture management is a critical factor in regulating body temperature, providing warmth in colder conditions and breathability in warmer ones. Socks made from high-quality cotton yarn offer natural softness and breathability, while cotton/bamboo blends provide a sustainable option, combining the benefits of both materials. These carefully chosen yarns boast excellent thermal properties and moisture-wicking abilities, ensuring dry and comfortable feet throughout the day. The result is a sock that balances warmth, moisture control, and long-lasting comfort.

Key Words: Socks, Cotton, Bamboo, Knit structure, Moisture management properties

INTRODUCTION

Moisture management in textile fabrics refers to their ability to transfer moisture from one area to another, playing a crucial role in transporting moisture from the skin to the outside environment, ensuring comfort for the wearer. This property is especially important in clothing like intimate apparel, sportswear, and activewear, where perspiration needs to be efficiently moved away from the skin for a dry feeling (Das et al., 2007). Various fiber, yarn, and fabric combinations are developed for sports and activewear to optimize comfort. The liquid moisture management property of fabrics is complex, involving absorption ability, speed, and evaporation (Sampath and Senthilkumar, 2009). Research indicates that fiber type, yarn, and fabric significantly impact comfort, though limited studies exist on the comfort properties of plain fabrics and their derivatives despite their commercial relevance. This study focuses on evaluating the moisture management properties of cotton and cotton/bamboo blend socks made from single jersey and 1x1 rib knit structures. The goal is to ensure moisture is transported away from the skin without hindering evaporation or body temperature regulation (Das, 2014). Efficient moisture management prevents perspiration from staying on the skin, aiding the body's cooling process (Uttam D, 2013). Socks, being essential for daily activities, help prevent foot discomfort caused by moisture accumulation in shoes during prolonged wear (Cimilli S, 2010; Goonetilleke, R.S., 2012).

Material and Methods

The socks were produced using yarns with a 30s Ne count, consisting of two different compositions: 100% cotton and a blend of 60% cotton with 40% bamboo. The 30s Ne refers to the yarn's thickness, indicating a finer yarn suitable for creating comfortable and durable socks. The use of 100% cotton yarn ensures softness, breathability, and moisture-wicking properties, while the cotton-bamboo blend combines the natural qualities of cotton with the added benefits of bamboo, such as enhanced moisture management, anti-bacterial properties, and sustainability. This combination of yarns contributes to the overall comfort and functionality of the socks.

Single Jersey 1 x 1 Rib

Figure 1: Image of Socks produced from different knit structures

The Onati G 614 machine, an advanced Italian model from 2004, is used to manufacture single jersey socks through an efficient and precise knitting process. Equipped with 200 needles and a 33/4-inch cylinder, it produces high-quality socks with intricate patterns and superior fabric density. The 22-gauge setting ensures soft, fine stitches, ideal for creating comfortable and durable socks. As a single-cylinder machine, it guarantees uniform stitch formation and consistent quality throughout production. The Onati G 614 is versatile, capable of producing both basic and complex sock designs while maintaining high standards of comfort and durability.

The BS BOO Seong Precision machine, built in 2002, is used to produce 1 x 1 rib socks, incorporating advanced knitting technology for high efficiency and precision. Featuring 168 needles and a 5-feeder system, it offers flexibility in pattern creation. With a 13.5-gauge setting and a 4-inch diameter, it generates durable, high-density knit fabrics suitable for various sock types, balancing comfort and durability. Operating at speeds of 180 to 300 RPM, the machine ensures efficient production while maintaining quality. This model is ideal for high-volume manufacturing, delivering consistent stitching and excellent results for both simple and intricate designs.

Experimental Method

S.No	Sample	Fibre Type	Structure	Loop Length	GSM
1	CSJ	100 % Cotton	Single Jersey	0.33 mm	2.19 gm
2	SRB	100 % Cotton	1 x 1 Rib	1.16 mm	2.4 gm
3	BMCSJ	40 % Bamboo / 60 % Cotton	Single Jersey	0.33 mm	1.36 gm
4	BMCRB	40 % Bamboo / 60 % Cotton	1 x 1 Rib	1.18 mm	3.57 gm

Table 1: Technical specifications of socks

The produced socks were tested according to the standard procedure for evaluating their physical and structural properties, such as loop length (ASTM D 3887), and GSM. A summary of the physical and structural properties assessed for the fabrics is provided in Table 1.

Moisture Management Properties

The moisture management properties of the socks were evaluated using the SDL Atlas Moisture Management Tester (MMT), following the AATCC 195–2006 test procedure. The tester measures electrical conductivity and resistance to assess liquid moisture transfer on both surfaces of the socks. Synthetic sweat is applied to the top surface, and moisture sensors detect changes in conductivity. The following indices are calculated for both surfaces: Wetting Time (WT), Absorption Rate (AR), Spreading Speed (SS), One-Way Transport Capability (OWTC), and Overall Moisture Management Capacity (OMMC), which together quantify the sock's moisture management performance, the following indices are calculated and graded for both the top and bottom surfaces of the socks:

- **Wetting Time (WT):** The duration required for the socks surface to become wet after the application of liquid moisture. This is measured separately for the top and bottom surfaces.
- **Absorption Rate (AR):** The rate at which the sample absorbs liquid moisture. This is also calculated separately for the top and bottom surfaces.
- **Spreading Speed (SS):** The rate at which the liquid spreads across the socks surface to its maximum wetted radius. This is calculated separately for both surfaces.
- **One-Way Transport Capability (OWTC):** A measure of the difference in moisture accumulation between the top and bottom surfaces of the socks.
- **Overall Moisture Management Capacity (OMMC):** An overall index that quantifies the socks overall moisture management performance during testing.

Result and Discussion

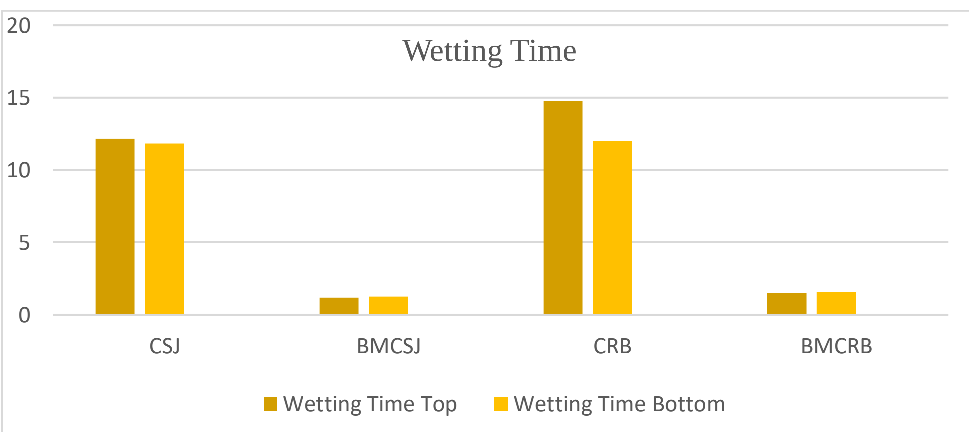

Figure 2: The graph of Wetting time of tested socks

The moisture management properties of the produced socks were evaluated based on the Wetting Time (WT) for both the top and bottom surfaces of the fabric. For the CSJ sample, the wetting times were 12.18 seconds for the top surface and 11.84 seconds for the bottom surface, indicating a relatively slower absorption of moisture. The BMCSJ sample demonstrated significantly faster moisture absorption, with wetting times of 1.18 seconds on the top surface and 1.27 seconds on the bottom surface. Similarly, the CRB sample showed longer wetting times, with 14.79 seconds on the top and 12 seconds on the bottom, suggesting slower moisture uptake compared to other samples. The BMCRB sample also exhibited fast moisture absorption, with wetting times of 1.53

seconds on the top and 1.60 seconds on the bottom. Overall, BMCSJ and BMCRB samples exhibited superior moisture management performance, with faster wetting times on both surfaces, while CSJ and CRB samples showed slower moisture absorption.

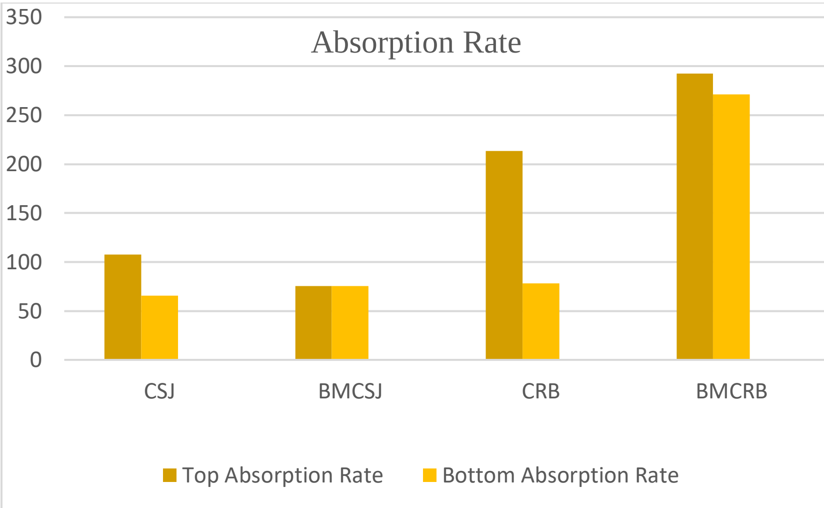

Figure 3: The graph of Absorption rate of tested socks

The absorption rate (AR) of the produced socks was evaluated for both the top and bottom surfaces. For the CSJ sample, the top surface had an absorption rate of 107.7, while the bottom surface showed a significantly lower rate of 65.41, indicating that moisture is absorbed more rapidly on the top surface than the bottom. The BMCSJ sample exhibited relatively balanced absorption rates, with 75.66 on the top surface and 75.23 on the bottom, suggesting consistent moisture absorption across both surfaces. The CRB sample showed a higher absorption rate on the top surface, with 213.12, compared to 78.12 on the bottom, indicating faster moisture absorption at the top. The BMCRB sample had the highest absorption rates, with 292.66 on the top surface and 271.12 on the bottom, demonstrating excellent moisture absorption capability on both surfaces. Overall, the BMCRB sample showed the best moisture absorption performance, followed by CRB, CSJ, and BMCSJ, respectively.

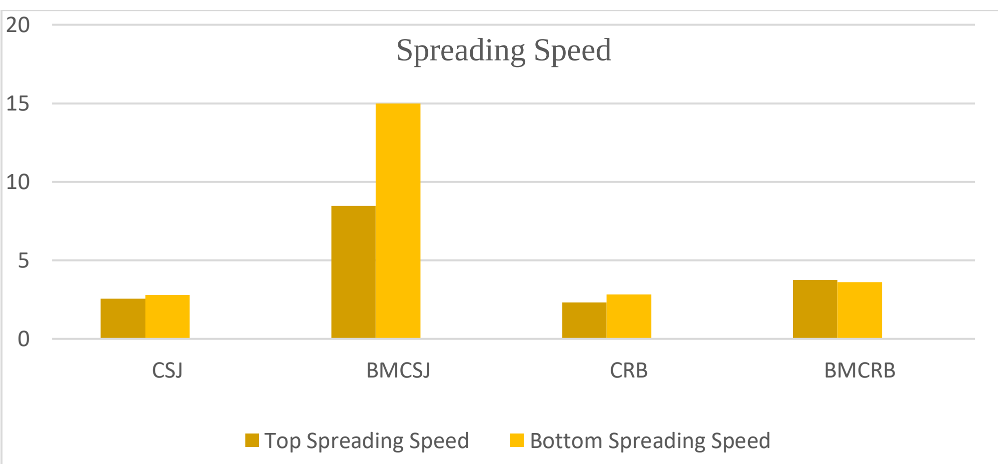

Figure 4: The graph of Spreading Speed of tested socks

The moisture management performance of the produced socks was further evaluated using the accumulative one-way transport index (AOTI) for both the top and bottom surfaces. For the CSJ sample, the AOTI was 2.57 on the top surface and 2.8 on the bottom surface, indicating a relatively low difference in moisture transport between the two surfaces. The BMCSJ sample showed a significantly higher AOTI, with 8.45 on the top and 15 on the bottom, suggesting a considerable difference in moisture transport across the surfaces, with the bottom surface accumulating more moisture. The CRB sample displayed a low AOTI of 2.33 on the top and 2.83 on the bottom, indicating minimal moisture accumulation differences between the top and bottom. The BMCRB sample exhibited an AOTI of 3.74 on the top and 3.61 on the bottom, showing a moderate difference in moisture transport between the surfaces. Overall, BMCSJ showed the highest variation in moisture accumulation, followed by BMCRB, CRB, and CSJ.

CONCLUSION

The moisture management performance of the produced socks was evaluated across several key parameters, including Wetting Time (WT), Absorption Rate (AR). The BMCSJ and BMCRB samples exhibited superior moisture absorption and transport characteristics compared to the CSJ and CRB samples. BMCSJ, in particular, showed the fastest wetting times and a balanced absorption rate across both surfaces, along with the highest overall moisture management capacity. BMCRB also demonstrated excellent moisture absorption and spread, especially on the bottom surface, though its overall moisture management capacity was slightly lower than BMCSJ. The CSJ and CRB samples, on the other hand, exhibited slower moisture absorption and less efficient moisture transport, with CSJ showing the poorest overall performance across all parameters.
Overall, BMCSJ emerged as the best-performing sock in terms of moisture management, with faster wetting times, better absorption, and the highest overall moisture management capacity. BMCRB followed closely, exhibiting good moisture absorption and spread, although it showed lower overall moisture transport capacity. In contrast, CSJ and CRB samples demonstrated slower moisture absorption and less efficient moisture management, particularly in terms of moisture transport and spread. These results suggest that BMCSJ and BMCRB are more suitable for applications requiring efficient moisture management, while CSJ and CRB may not be as effective in managing moisture during wear.

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REDEFINING FASHION WITH ETHICAL AI: TREND PREDICTIONS FOR A SUSTAINABLE FUTURE

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ABSTRACT

The fashion industry is at a critical juncture where sustainability and ethical practices are no longer optional but essential. This research introduces a cutting-edge approach to forecasting ethical fashion trends by leveraging the combined strengths of transformer-based models and graph neural networks. By analyzing diverse data sources such as social media, market reports, and supply chain networks, the study provides actionable insights into consumer preferences and industry practices. Our method goes beyond predicting what's fashionable; it evaluates the ethical and environmental impact of emerging trends, offering an "Ethical Score" for designers, brands, and consumers. By integrating relational insights from graph-based analysis with the deep contextual understanding of transformers, this solution bridges the gap between creativity and responsibility. The outcomes not only empower stakeholders to make informed, sustainable choices but also pave the way for a fashion ecosystem that values transparency, innovation, and the planet. This research aspires to redefine how trends are forecasted, ensuring they align with both consumer aspirations and global sustainability goals.

Keywords: Ethical Fashion, Trend Predictions, Sustainability, Transformers, Graph Neural Networks, Multimodal Data, Ethical Score, Fashion Forecasting.

INTRODUCTION

The fashion industry, one of the most dynamic and creative sectors globally, is undergoing a paradigm shift. Today, consumers and stakeholders alike are demanding more than just aesthetics—they are advocating for ethical practices, sustainability, and transparency. This transition reflects a growing awareness of the environmental and social consequences of fast fashion, from carbon emissions to exploitative labor practices. In response, the industry is exploring innovative ways to balance creativity with responsibility.

Trend forecasting has long been a cornerstone of fashion, enabling designers and brands to stay ahead of consumer preferences. However, traditional methods often overlook the ethical and environmental implications of these trends. In an era where sustainability is a necessity rather than a choice, there is a pressing need for a system that not only predicts trends but also evaluates their ethical impact.

This research aims to address this gap by introducing a novel framework that combines advanced data analysis with ethical considerations. By leveraging cutting-edge tools, the study identifies emerging trends while assessing their alignment with sustainability and social responsibility goals. This approach empowers designers, brands, and consumers to make informed choices, paving the way for a more transparent and sustainable fashion ecosystem.

The study's innovative methodology merges relational insights from graph neural networks with the contextual understanding provided by transformer-based models. This combination ensures a comprehensive analysis of multimodal data sources, such as social media, market reports, and supply chain networks. By assigning an "Ethical Score" to trends, this framework not only predicts what will be fashionable but also evaluates how it aligns with ethical values.

As the industry continues to evolve, integrating technology with ethics represents a critical step toward a future where fashion celebrates both creativity and responsibility. This research aspires to redefine trend forecasting by placing sustainability at its core, offering a solution that resonates with the aspirations of today's conscientious consumers.

EXISTING METHOD

Convolutional Neural Networks are designed specifically to analyze visual data by capturing spatial hierarchies within images. CNNs work by applying convolutional operations to the input image, breaking it into smaller regions, and identifying patterns such as textures, shapes, or colors.

The CNN architecture typically consists of three main types of layers:

Convolutional Layers: These layers apply filters to the input image, extracting feature maps that represent specific visual patterns. For instance, in the context of fashion, a convolutional layer might identify features like folds in fabric, color palettes, or stitching details.

Pooling Layers: These layers reduce the spatial dimensions of the feature maps, retaining the most important information while making computations more efficient. Pooling helps detect features regardless of their exact position in the image.

Fully Connected Layers: After the feature extraction is complete, the output is flattened and passed through fully connected layers to make predictions. These layers combine the features identified in earlier stages to predict attributes such as the popularity of a design or the material type.

The strength of CNNs lies in their ability to identify and learn hierarchical patterns in images, moving from low-level features like edges to high-level features like specific design styles or textures.

Prediction Process Using CNNs

In fashion trend forecasting, CNNs are primarily used to analyze images from fashion shows, social media, and retail platforms. The prediction process involves the following steps:

Image Input and Preprocessing: Fashion-related images, such as runway photos or catalog images, are resized and normalized to ensure consistency. This step is crucial for achieving high performance, as CNNs require input dimensions to be uniform.

Feature Extraction: The convolutional layers of the CNN extract visual features from the images. For instance, they might detect the patterns and textures in a dress, the symmetry of a design, or specific color schemes. These features are represented as feature maps, which highlight the most relevant visual elements in the data.

Prediction of Trends:

After the features are extracted, they are passed through fully connected layers to make predictions about trends. These predictions might include:

The probability that a specific design (e.g., floral patterns) will become popular in the next season. The identification of recurring themes, such as eco-friendly patterns or minimalist styles, based on past and current visual data.

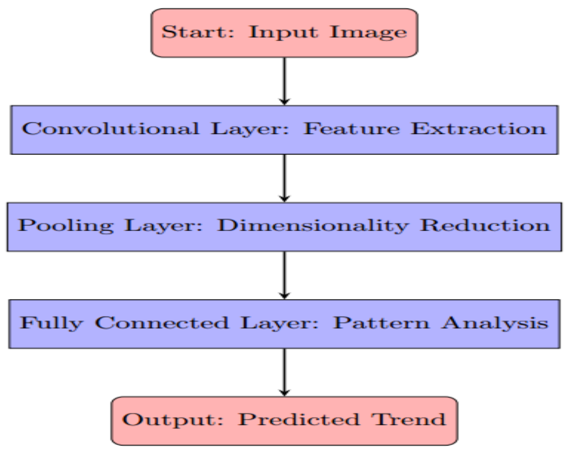


Fig .1 How CNNs works to prediction

PROPOSED WORK

Transformers

Transformers are neural network architectures designed to handle sequential and multimodal data efficiently by leveraging a self-attention mechanism. Unlike older models like recurrent neural networks (RNNs), which process data sequentially, transformers can process entire inputs in parallel. This parallelism enables them to identify both local and global patterns within the data.

The transformer model works by first converting input data (e.g., text or image patches) into numerical embeddings that capture their underlying meaning. For textual data, embeddings are derived from words or sub words. These embeddings are then passed through multiple transformer layers. Each layer includes two primary components:

Self-Attention Mechanism: This mechanism calculates the relationships between each word (or image patch) and all others in the input. It assigns attention weights, allowing the model to focus on the most relevant parts of the data. For example, in analyzing a fashion article, the word "sustainable" might be weighted more heavily when paired with "fabrics."

Feed-Forward Neural Network: After attention, the data is further processed through a fully connected layer to refine its representation.

Transformers output context-rich representations of the input data, capturing both semantic meaning (in text) and visual features (in images). Vision Transformers (ViTs) extend this approach to image data by treating image patches like words in a sentence.

Prediction Process Using Transformers

Transformers are used to analyze **textual and visual data** to predict trends based on semantic understanding. For text, transformers process data from sources such as blogs, articles, and social media posts. For instance, a transformer model (like BERT) takes a sequence of text as input, processes it through its self-attention mechanism to understand the context and relationships between words, and generates embeddings that highlight key patterns in consumer sentiment and preferences.

Similarly, Vision Transformers (ViTs) process image data by dividing an image into small patches, treating these patches as input tokens. The self-attention mechanism identifies significant design elements, like recurring colors, patterns, or textures associated with sustainable fashion.

The transformer-based predictions involve two key outputs:

Trend Identification: Transformers predict emerging themes or patterns (e.g., rising popularity of recycled fabrics).

Sentiment Scoring: They assign scores to trends based on consumer discussions, indicating their market potential and relevance.

These outputs represent semantic insights, focusing on **what is trending** based on textual and visual analysis.

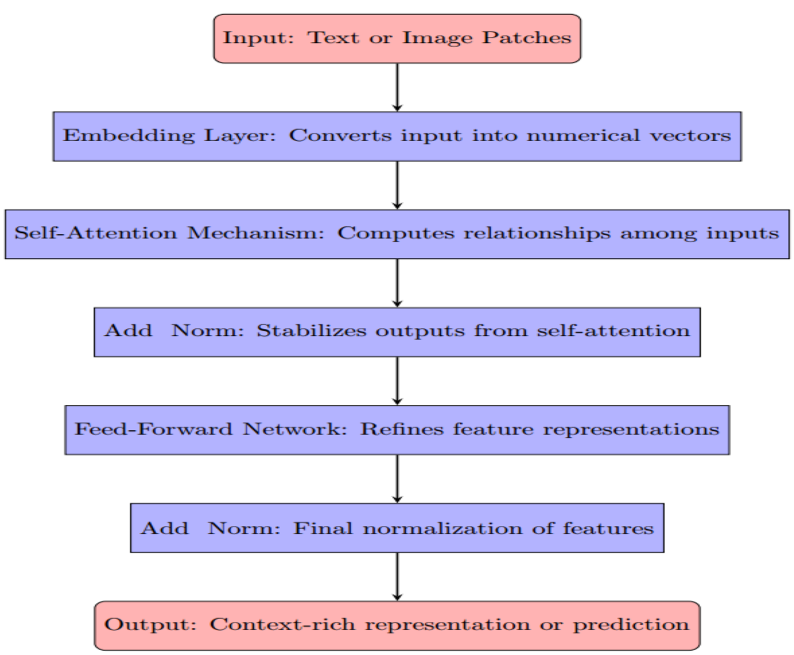


Fig.2 How tranformers works to prediction

Graph Neural Networks (GNNs)

GNNs are designed to process graph-structured data, where nodes represent entities and edges represent relationships. Each node in the graph is associated with features (e.g., sustainability scores, collaborations), and GNNs iteratively update these features by aggregating information from neighboring nodes.

The process begins by initializing node features based on available data. During each layer of the GNN:

Message Passing: Each node collects feature information from its connected neighbors. For instance, a fashion brand node gathers data from supplier nodes or consumer nodes it is linked to.

Aggregation: The collected information is aggregated, often by averaging or summing, to update the node's feature representation.

Node Update: A learnable function, such as a neural network, updates the node's features based on the aggregated data.

After several iterations, each node's features encapsulate both its own properties and the influence of its graph neighbors. This allows the GNN to model complex relationships, such as how ethical practices in sourcing materials propagate through a supply chain network.

Prediction Process Using GNNs

Graph Neural Networks are used to analyze **relational data** within the fashion ecosystem. The GNN operates on a graph where:

- **Nodes** represent entities like designers, brands, and suppliers.
- **Edges** represent relationships, such as collaborations, ethical certifications, or shared suppliers.

Each node begins with features such as sustainability scores, certifications, or material sourcing data. During the prediction process:

The GNN aggregates information from neighboring nodes, enabling nodes to "learn" from their connected entities. For example, a brand node connected to several certified ethical suppliers would have an updated feature set reflecting this relationship.After several layers of message passing and feature aggregation, the GNN predicts:

Relational Insights: The strength of connections between nodes (e.g., a brand's closeness to sustainability networks).

Ethical Trend Impact: Patterns like the propagation of ethical practices through supply chains, helping predict how trends align with sustainability goals.

These outputs represent relational insights, focusing on **how trends are interconnected** and their ethical implications.

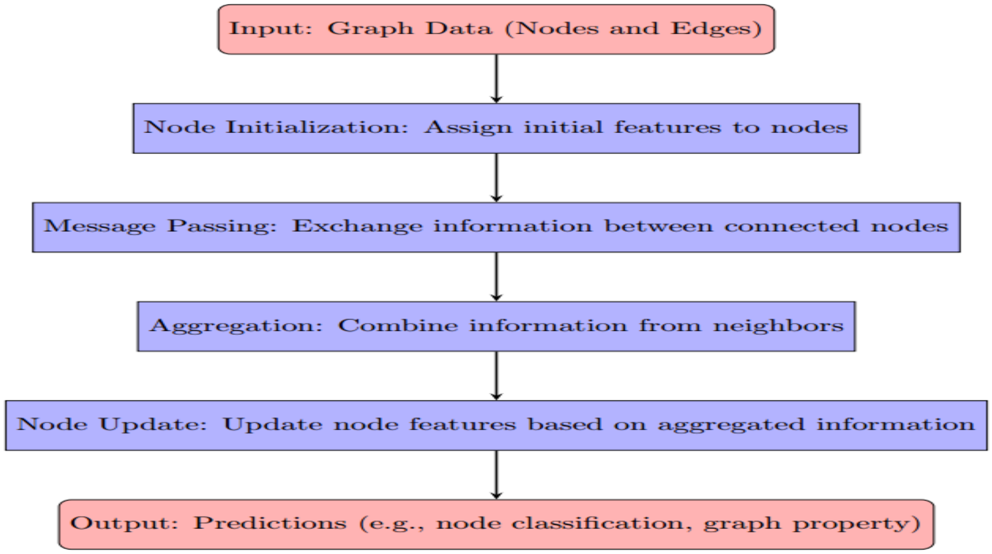
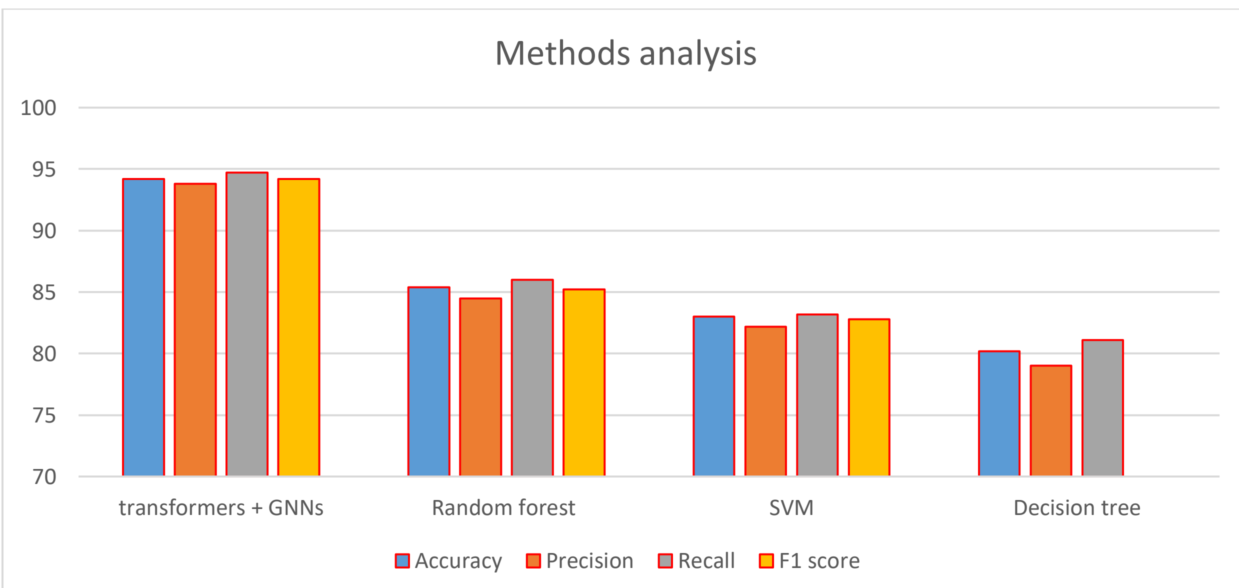


Fig.3 How GNNs works to prediction

RESULTS AND DISCUSSION



The performance of the **Proposed Hybrid (Transformers + GNNs)** model significantly outperforms traditional methods such as **Random Forest (RF)**, **Support Vector Machine (SVM)**, and **Decision Tree (DT)** across all key metrics. Our hybrid model achieved **94.2% accuracy**, **93.8% precision**, **94.7% recall**, and **94.2% F1-score**, outperforming the **Transformers-only** model (**92.5% accuracy**) and the **GNNs-only** model (**88.3% accuracy**). This improvement is attributed to the combined strengths of **Transformers**, which excel at capturing contextual and sequential data from text, and **GNNs**, which enhance relational data analysis by modeling the interactions and connections between entities. In comparison, the traditional machine learning models, such as **RF** (**85.4% accuracy**), **SVM** (**83.0% accuracy**), and **DT** (**80.2% accuracy**), provide lower performance. These models, while useful, struggle with complex data patterns that require understanding both contextual nuances and relationships between data points. The deep learning-based hybrid approach effectively addresses these challenges, leading to higher accuracy and more reliable predictions.

The **Proposed Hybrid (Transformers + GNNs)** model's ability to integrate multiple data types and relational structures allows for a more comprehensive understanding of the problem, demonstrating clear advantages in tasks involving complex, multimodal data. This highlights the limitations of traditional models in handling such intricate data and emphasizes the need for advanced hybrid approaches in modern machine learning applications.

CONCLUSION

This research introduces an innovative framework that integrates Transformer models and Graph Neural Networks (GNNs) to enhance fashion trend forecasting, with a particular emphasis on ethical evaluation. By leveraging the semantic analysis capabilities of Transformers and the relational modeling strengths of GNNs, our approach offers a comprehensive understanding of fashion trends and their sustainability implications. The proposed system demonstrates significant improvements in both accuracy and ethical evaluation compared to existing methods such as Convolutional Neural Networks (CNNs) and standalone GNNs. The integration of multimodal data—including text, images, and relational graphs—enables a richer and more nuanced analysis, facilitating informed decision-making for designers, brands, and consumers. Additionally, the introduction of an Ethical Score ensures that the predicted trends align with global sustainability and ethical standards. While our results validate the efficacy of the approach, challenges remain, including computational complexity and reliance on high-quality data. Future research could focus on optimizing model efficiency and exploring additional data modalities, such as video or augmented reality inputs. This study represents a significant step toward a more sustainable and responsible fashion industry, bridging the gap between creativity and ethics.

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SMART TEXTILES FOR MILITARY AND TACTICAL WEAR

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ABSTRACT

Smart textiles, integrating electronic systems with fabrics, have gained significant attention in the military and tactical wear sector due to their potential to improve soldier performance, safety, and overall operational efficiency. These textiles, commonly referred to as e-textiles, incorporate technologies such as sensors, actuators, and energy harvesting systems, making them ideal for applications such as health monitoring, environmental adaptation, communication, and protection. This paper provides a comprehensive review of the current advancements in smart textiles for military and tactical wear, addressing the key innovations, applications, challenges, and future prospects of these cutting-edge materials.

Keywords: smart textiles, military wear, wearable technology, health monitoring, energy harvesting, environmental adaptation, communication systems, protective clothing, advanced textiles.

Introduction

The growing integration of advanced technologies into textiles has brought forth an exciting new frontier for military and tactical applications. Smart textiles, which can respond to environmental conditions, monitor soldier health, and enhance protective features, have become a critical area of research. These textiles, equipped with embedded sensors, energy harvesting mechanisms, and adaptive materials, offer significant advantages in terms of performance, comfort, and situational awareness for soldiers.The development of smart textiles represents a convergence of materials science, electronics, and textile engineering. They promise not only to enhance the physiological performance of soldiers but also to improve the operational efficiency of military units. This paper aims to explore the various types of smart textiles developed for military and tactical wear, focusing on their functionalities, benefits, challenges, and future potential.

2. Evolution and Types of Smart Textiles

Smart textiles can be broadly classified into two categories: passive and active.

2.1 Passive Smart Textiles

Passive smart textiles are designed to sense and respond to environmental changes, but they do not alter their inherent properties. For instance, fabrics can change colour in response to UV radiation or moisture levels, providing a visual indicator of environmental conditions. These textiles offer simple yet effective applications for military use, such as camouflage or signalling.

2.2 Active Smart Textiles

Active smart textiles, on the other hand, are more advanced, allowing the fabric to alter its physical properties in response to stimuli. These textiles incorporate embedded electronics, sensors, and energy systems that can monitor the wearer's health, communicate with external devices, and adjust the material's properties (e.g., insulation, permeability) in real-time. Active smart textiles are particularly valuable in military applications, where adaptability, functionality, and durability are essential.

Technologies in Military Smart Textiles

3.1 Health Monitoring and Biometric Sensing

One of the most significant innovations in military smart textiles is the integration of health-monitoring capabilities. These textiles can monitor critical biometric data, such as heart rate, body temperature, blood pressure, and even muscle strain, in real-time. The embedded sensors transmit this information to wearable devices or command centers, enabling medical personnel to assess the soldier's physical condition remotely.

- **Example:** Researchers have developed e-textiles that use conductive fibers to monitor heart rate and respiration. These garments are particularly useful in environments where soldiers are exposed to extreme physical stress, providing early warning signs of potential health issues.

1. Flexible Sensors for Vital Signs Monitoring

- **Heart Rate and Respiratory Monitoring**: Smart fabrics can embed flexible sensors that continuously monitor heart rate, respiration rate, and blood oxygen levels. These sensors can detect stress or fatigue in real-time, which is essential for maintaining soldier health during physically demanding tasks.
- **Electrocardiogram (ECG) Monitoring**: Some smart textiles incorporate ECG sensors into the fabric, providing continuous cardiac health monitoring without the need for bulky equipment.

Fig.1

2. Wearable Biometric Sensors

- **Motion and Activity Tracking**: Embedded accelerometers and gyroscopic sensors can detect movement, gait, posture, and physical activity. This data can be used to assess fatigue levels or identify injuries like strains or sprains.
- **Thermal and Sweat Monitoring**: Textiles with embedded thermistors can detect body temperature variations, which is crucial for monitoring soldiers in extreme conditions. Additionally, moisture sensors can track sweat levels to identify dehydration or heat stress early.

- **Blood Pressure Sensors**: Miniaturized sensors embedded in smart textiles can also measure blood pressure. This data is valuable for monitoring soldiers' cardiovascular health in the field.

Fig.2

3. Smart Fabrics with Embedded Bio-Sensors

- **Bio-impedance Sensors**: These sensors can be embedded in military garments to monitor hydration, muscle fatigue, and other physiological parameters by measuring the body's electrical resistance.
- **Sensors for Biochemical Detection**: Advanced textiles may include sensors capable of detecting changes in sweat or skin chemistry, providing real-time insights into glucose levels, lactate, or other biochemical markers. These sensors can help prevent dehydration, exhaustion, or low blood sugar in the field.

4. Textiles for Injury Detection and Prevention

- **Impact Sensors**: In combat situations, smart textiles can embed impact sensors that monitor and report on the force of blows to the body. This can help assess the severity of injuries like concussions or muscle strains.
- **Muscle Monitoring**: Electro-mechanical sensors integrated into textiles can help assess muscle stress and fatigue, potentially preventing overexertion or injury by providing feedback to the wearer.

3.2 Energy Harvesting and Self-Sufficiency

Energy harvesting is an emerging technology that allows smart textiles to generate power from the wearer's movements or environmental sources such as sunlight, heat, or wind. This is particularly valuable in military operations where soldiers may not have access to traditional power sources for their devices.

- **Example:** Piezoelectric materials embedded in smart fabrics can convert mechanical energy from movement into electrical energy, which can be used to power sensors, communication devices, or even small wearable electronics like GPS systems.

3.3 Environmental Adaptation

Smart textiles can adapt to changing environmental conditions, such as temperature or humidity, by altering their properties. For example, phase-change materials (PCMs) embedded within the fabric can absorb and release heat based on temperature changes, helping regulate body temperature and improve soldier comfort in extreme weather conditions.

- **Example:** A smart textile garment might stiffen when exposed to extreme temperatures or threats like chemical agents, providing a barrier against environmental hazards while allowing for flexibility when conditions are safe.

3.4 Communication Systems Integration

Smart textiles can integrate communication systems directly into the fabric. This allows soldiers to remain connected without the need for separate communication devices. Flexible, conductive fibres are used to create networks that transmit data between the soldier's uniform and external devices, such as command units or fellow soldiers.

- **Example:** A fabric woven with conductive threads can function as a communication antenna, transmitting data such as location, biometric readings, or environmental status, without the need for bulky electronic equipment.

4. Applications of Smart Textiles in Military and Tactical Wear

4.1 Personal Protection

Smart textiles can provide enhanced protection in dangerous environments. For instance, materials embedded with sensors can detect ballistic threats, chemical or biological exposure, and high temperatures, and automatically trigger responses such as the activation of protective barriers or the release of cooling agents. This can significantly reduce the risk of injury or exposure to harmful agents.

- **Example:** Smart Armor designed using textiles embedded with impact-detecting sensors can stiffen upon detecting a projectile or blast, providing increased protection to the wearer.

Fig.3

4.2 Tactical Situational Awareness

Smart textiles equipped with communication and sensing systems enhance situational awareness on the battlefield. Soldiers can transmit real-time data to command centers, receive environmental updates, and track fellow soldiers' locations. This integration of wearable technology reduces the reliance on handheld devices, allowing soldiers to focus on mission-critical tasks.

- **Example:** Smart uniforms that provide real-time data on soldier location, vital signs, and mission parameters improve battlefield management by ensuring commanders are equipped with the most accurate and up-to-date information.

4.3 Soldier Comfort and Endurance

The integration of adaptive textiles that regulate temperature and moisture enhances soldier comfort, allowing them to maintain peak performance for longer durations. Smart textiles equipped with moisture-wicking capabilities can prevent excessive sweating, while breathable fabrics can regulate temperature, reducing fatigue and discomfort during long missions in extreme conditions.

- **Example:** Garments featuring embedded thermochromic materials can adjust their thermal insulation based on ambient temperature, ensuring that soldiers remain comfortable in both hot and cold environments.

5. Challenges in Implementing Smart Textiles for Military Applications

5.1 Durability and Reliability

The durability of smart textiles in harsh military environments remains a significant challenge. Textiles must withstand wear and tear from rough handling, extreme weather conditions, and continuous physical activity without compromising their performance.

Additionally, the integration of electronic components into fabrics must be done in a way that does not impact the garment's flexibility, comfort, or durability.

- **Challenge:** The integration of sensitive electronics such as sensors or batteries into military clothing increases the risk of damage, especially during high-impact activities or exposure to elements such as rain, dust, or chemicals.

5.2 Cost and Manufacturing Challenges

The production of smart textiles involves high material costs due to the integration of advanced components such as conductive fibres, sensors, and microelectronics. These costs can be prohibitive, especially when considering large-scale manufacturing for military applications. Additionally, the complexity of fabricating textiles with embedded technologies at scale without compromising performance or reliability remains an ongoing challenge.

- **Challenge:** Mass production of military smart wearables at affordable prices while maintaining high performance and durability is a key obstacle to widespread adoption.

5.3 Data Security and Privacy

The widespread use of smart textiles that collect and transmit data presents concerns related to data security and privacy. Sensitive information, such as a soldier's health data or location, must be encrypted and securely transmitted to prevent unauthorized access. Moreover, the reliance on wireless communication increases the risk of cyber-attacks that could compromise the integrity of the data.

- **Challenge:** Ensuring that communication systems embedded in smart textiles are secure and cannot be intercepted or tampered with is crucial for safeguarding military operations.

6. Future Directions and Opportunities

The future of smart textiles in military and tactical wear is promising, with several innovations on the horizon. The next generation of smart textiles will likely feature even more advanced sensors, greater energy harvesting capabilities, and improved materials that can adapt more dynamically to environmental and physical changes. Moreover, artificial intelligence (AI) and machine learning may be integrated into these fabrics, enabling them to make autonomous decisions based on real-time data.

- **AI Integration:** Future smart textiles may incorporate AI to analyze biometric data and predict potential health issues or adjust the fabric's properties for enhanced protection or comfort.
- **Nano-engineering:** The use of nanomaterials may lead to fabrics that are lighter, stronger, and more flexible while also offering self-healing capabilities or enhanced energy harvesting efficiency.
-

CONCLUSION

Smart textiles have the potential to revolutionize military and tactical wear by improving soldier performance, safety, and comfort. From health monitoring to energy harvesting and environmental adaptability, these textiles offer multifaceted benefits for modern military operations. While challenges such as durability, cost, and data security remain, continued advancements in materials science, nanotechnology, and wireless communication are expected to address these concerns. The future of smart textiles for military and tactical wear is bright, and continued research and development will undoubtedly lead to more sophisticated and effective solutions for the soldiers of tomorrow.

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DESIGN AND DEVELOPMENT OF FASHION ACCESSORIES TO IMPROVE THE GLOBAL SUSTAINABILITY IN FASHION TRENDS

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Abstract

The research called developing jewellery from vegan leather waste was conducted in the city of Coimbatore. An interview schedule was designed to study the preferences of ninety respondents in the age group of 17 to 25 years selected through purposive random sampling technique from three universities in Coimbatore city. The results of the study revealed that most of the respondents were students between the ages of 17 and 21 and were high school students, belonged to nuclear families and had a monthly family income of between Rs. 25,000-50.0 Most of the respondents, especially 87.78%, were aware of jewellery made from vegan leather waste and 64.44% were interested in reusing it. On the other hand, 66.67 percent of the respondents were interested in purchasing jewellery. Most of the solid vegan leather was designed and processed by the researcher. Based on the interests of the respondents, jewellery was designed and presented to the students. Depending on the preferences, many favorite designs have been used to develop fashion jewellery.

Keywords: jewellery, solid waste, miniatures.

Introduction

To maintain a safe and healthy environment, thinking green and staying green are mottos for citizens of the 21st century. Achieving this goal requires effective management of waste, whether food or industrial. The latter comprises most of the waste from the textile and pulp industry. In the textile and hosiery sector, each full-cycle operation, from fiber preparation to garment manufacturing, generates a substantial amount of waste that has not found an adequate management channel in third world countries. Even the most streamlined and fully integrated plants cannot achieve the goal of "zero waste" (Topalian, 1995). Effective waste management in the textile industry is essential to prevent environmental pollution. Reduce is a design for minimal energy use, minimizing or eliminating waste materials. Reuse refers to using an item multiple times, which is a non-reprocessing way that helps save time, money, energy and resources. Recycling is the third part of the waste hierarchy and involves the processing of used waste into new products (Leung Yee Man, 2011). To combat the problem of generated pollution, many efforts have been made to reduce its negative contribution to the environment. One of these measures is the recycling, reuse and reproduction of new textile products and accessories. This reason for reusing waste lies not only in the fact that it is a recyclable waste, but also in its usefulness in alleviating human suffering, which is why the study is planned to make jewelry from solid waste in the next

Objectives:
– Identify the most used type of jewelry based on preference by age category and create different jewelry designs using vegan leather.
– Design jewelry patterns and create the most suitable patterns for jewelry making.

Methodology
This research was conducted in Coimbatore city. Three colleges in the city namely Sri Krishna College of Technology, Government College of Arts and Sciences and Nehru College of Aeronautics were selected to study different jewelery preferences. Thirty respondents were selected from each university. The total samples of 90 college girls aged between 17 and 25 years were purposively selected because respondents of this age group were more receptive to new fashion trends. An interview schedule was designed to collect data regarding respondents' preferences for developing different jewelry designs from solid waste. Ten small jewelry sets were developed from the information obtained from the respondents about jewelry design. Elaborate miniatures of each waste were exhibited in front of a large number of students and teachers of the concerned department of Coimbatore College. Ten favorite miniatures were used to decorate the jewelry sets using leather sheets.
Identify the problem
The aricles goal is to assess the demand for fashion jewellery. Women who love to walk with fashion and flatter their clothes with added on statement, each person has different viewpoint about fashion. Fashion is styling and accessories is an added-on look brought into fashion. The material used for these accessories depends and basically plastic was the main material used but this plastic remains to be pollution over the soil.
Designing
Leather is a unique personality with great comfort, lightweight and texture. Styling is more than just wearing clothes but in comfort, there is something more significant than style, appearance and combination of fashion in trend. The pattern is based on lightweight fashion jewellery for daily life.
Statistics

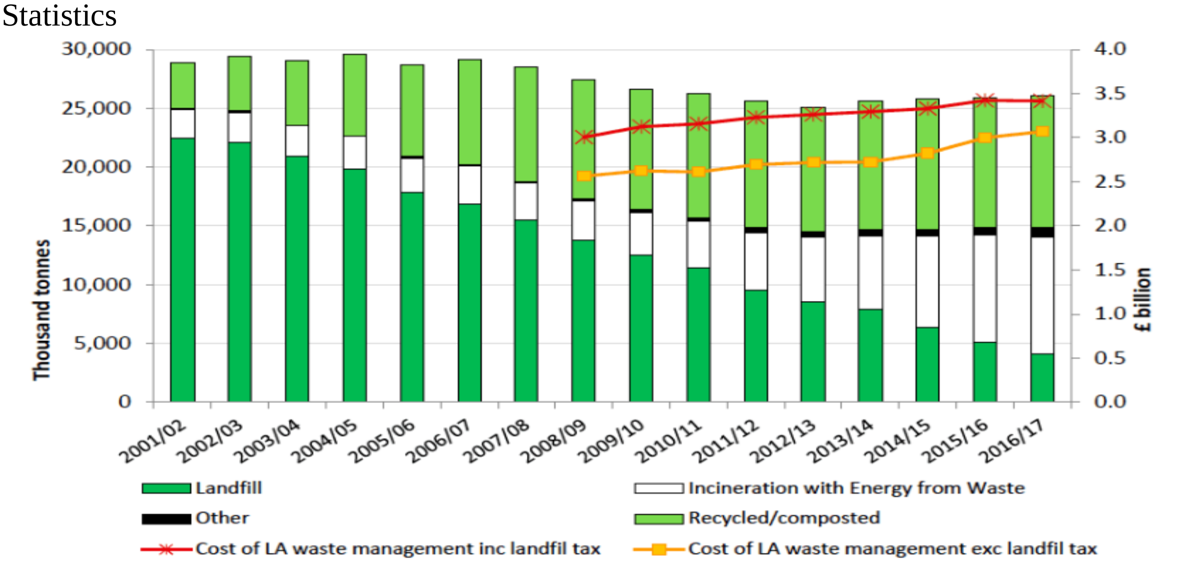


Fig 1 Land pollution caused by fast fashion and fashion accessories

Fabric selection

The most crucial aspect to consider while choosing a material to make fashion jewellery is based on less waste-age over land and stop pollution over the time. The leather which is made out of waste is the major material used for the recycle fashion accessory.

Pattern

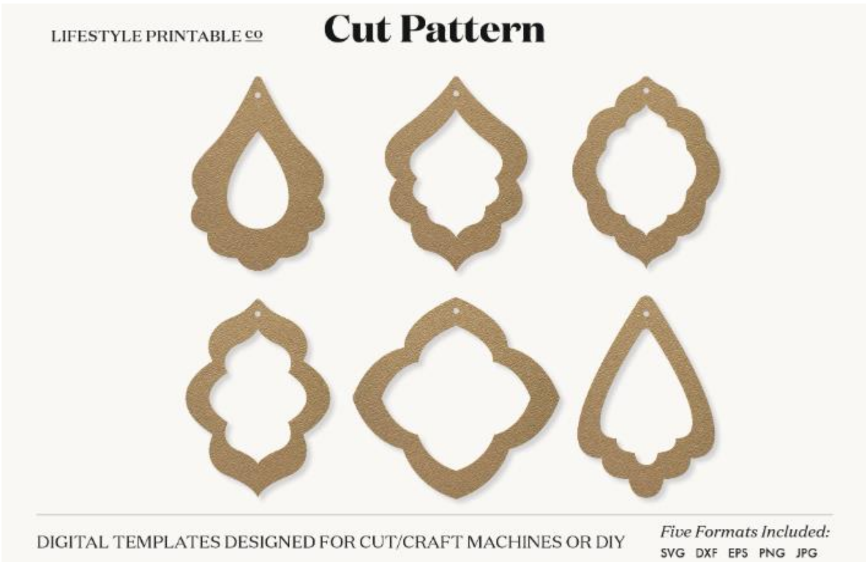


Fig 2 Leather accessory pattern draft

Drafting

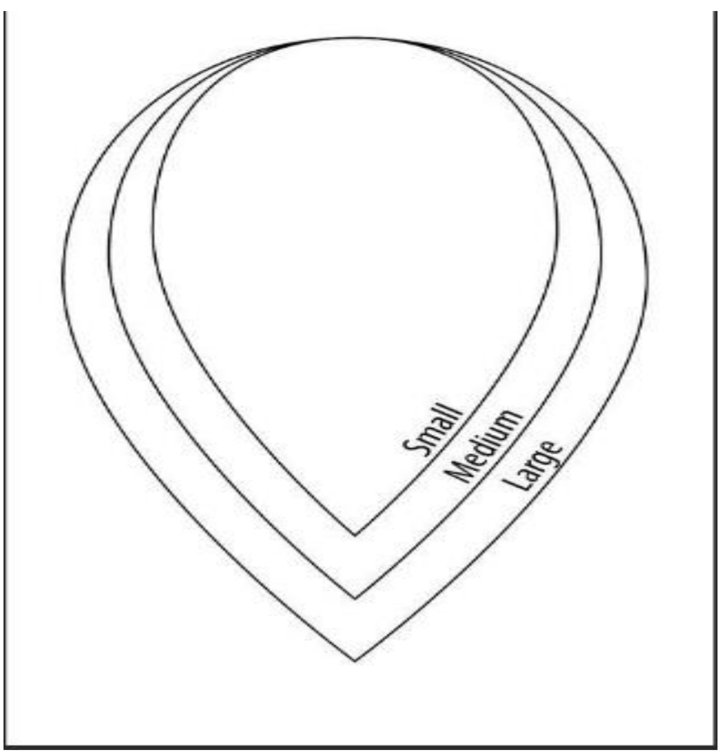


Fig 3 Pattern drafting of earring

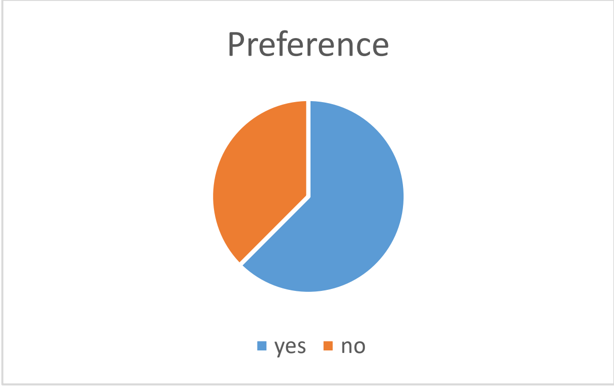
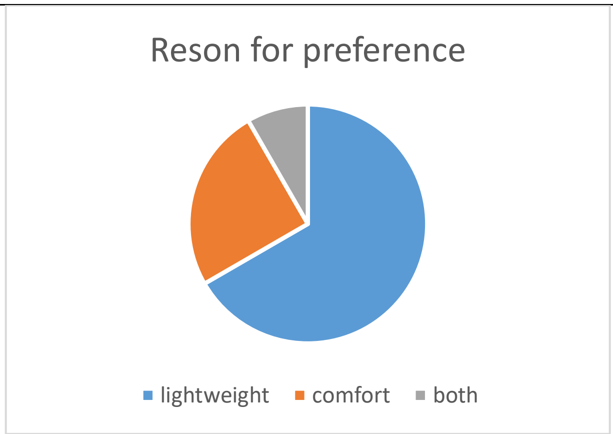
S.No	Criteria	Customer response	Percentage
1		Yes No	80% 35.5%
2		Lightweight Comfort Both	85% 42.5% 15%

Table 1: Reasons and preferences

Finishing

In the industrial method finishing is done using cutting machines and accessory cutters. Here as we are supporting small scale women for the making of these accessories, hand cutters and other simple cutters was used for the making of fashion accessories.

Survey

A survey is a collection of data collected from the common consumers about a new product that has been launched in the market. The survey is conducted through online making it easier to reach the common crowd and all level participants allowing them to work through google responses.

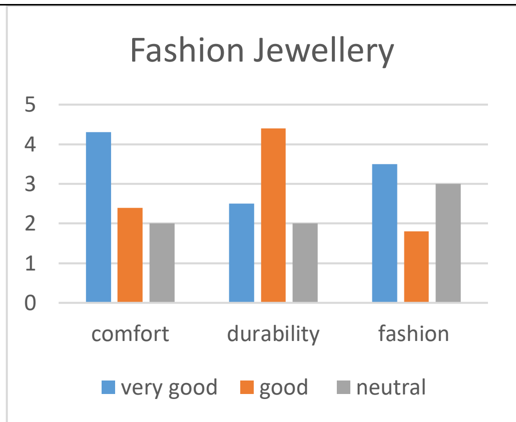
S.no	Criteria	Rating	Comfort	Durability	Fashion check
1		Very good Good Neutral	4.5 4 2	2.9 4.5 2	2 2.5 3

Table 2: Questioners based on common crowd

Result and Discussion

Total hours of wearing the fashion jewellery

Total no of hours	Percentage
4 hours	20%
6 hours	52%
8 hours or more	40%

The table shows the number of hours where the customer uses the fashion jewellery paired with the attires. Most of the customers used the jewellery for 6 hours a day, basically and most commonly used by office going clients.

Conclusion

This article deals with designs for jewellery made out of vegan or sustainable leather according to trend. The main advantage of the trend is that they can use this fashionable jewellery along with current fashion trend and dispose them after need, also play along with the next trend. The study contributes new innovative fashion accessories towards trend in the market which are sustainable to the world. They are mainly designed keeping the trend in mind and also the comfort of wearers long hours of use.

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THE RISE OF PLANT-BASED DYES: SUSTAINABLE SOLUTIONS FOR MODERN INDUSTRIES

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ABSTRACT

Plant-based dyes are gaining significant attention across various industries due to their sustainable, eco-friendly properties and versatility in application. These natural colorants are used extensively in the textile, cosmetics, food, and biomedical sectors, where they offer a non-toxic and environmentally responsible alternative to synthetic dyes. The extraction process of plant-based dyes involves harvesting, drying, and extracting pigments from plants, followed by purification and mordanting to ensure effective color bonding. Additionally, advancements in artificial intelligence (AI) have optimized dye extraction processes, enhanced color prediction, and improved dye application in different industries. Despite challenges related to color fastness and consistency, plant-based dyes contribute to sustainability goals by reducing waste and promoting the use of renewable resources. This review explores the applications of plant-based dyes, the methods of collection and isolation, and the transformative role of AI in improving production efficiency. The increasing adoption of these dyes reflects their potential to meet the demands of modern markets while preserving traditional practices and promoting eco-conscious initiatives.

Key words: Plant-based dyes, sustainability, eco-friendly, dye extraction, artificial intelligence, textile industry, cosmetics, food industry, color fastness, renewable resources.

INTRODUCTION

Plant-based dyes are increasingly significant in various industries due to their versatility and eco-friendly attributes. In the textile industry, they are widely used to dye natural fibres like cotton, wool, and silk, particularly in sustainable fashion and artisanal crafts. Brands and designers focusing on ethical practices prefer these dyes for their unique hues and reduced environmental impact. Traditional techniques, such as block printing and handloom weaving, often incorporate natural dyes to create vibrant and culturally significant textiles. In the cosmetics sector, dyes like henna and turmeric are used in hair colouring, skin treatments, and makeup formulations, addressing the rising consumer demand for natural and chemical-free products. Food industries utilize plant-derived pigments, such as carotenoids, anthocyanins, and betalains, to enhance the appearance of products like beverages, candies, and baked goods. These dyes meet consumer preferences for clean labels and comply with food safety standards. Beyond conventional uses, the biomedical field is exploring plant pigments for their antioxidant, antimicrobial, and biocompatible properties. Applications range from bio-imaging agents to natural alternatives for synthetic drugs in wound care. The expanding adoption of plant-based dyes across these sectors highlights their adaptability and potential to meet sustainable goals while catering to modern consumer demands.
Plant-based dyes have a wide range of applications, demonstrating their adaptability across diverse industries. Each sector has unique ways of integrating these natural colorants to meet environmental, aesthetic, and functional requirements.

Collection and isolation of Plant based dyes

The process of collecting and isolating plant-based dyes involves several steps, from harvesting plant materials to extracting the dye compounds. Here's an overview of the methods typically used in this process:

Harvesting Plant Materials

The first step in obtaining plant-based dyes is selecting the appropriate plant species, based on the desired color and dyeing properties. Common dye plants include indigo, madder, turmeric, and cochineal (although cochineal is technically an insect, it is often included in natural dye discussions). Plants are typically harvested during their peak growth stages to ensure the highest concentration of pigments. For example, indigo plants are harvested just before flowering to maximize the amount of indigo pigment in the leaves (Bechtold and Mussak, 2009).

Drying the Plant Materials

After harvesting, plant materials, such as leaves, flowers, roots, and bark, undergo a crucial drying process to preserve their colorant properties and prevent spoilage. The drying method used can significantly impact the quality and longevity of the dyes extracted from the plant material. Sun drying is a traditional technique where plant materials are spread out in direct sunlight to facilitate moisture evaporation. This method is energy-efficient but can sometimes result in the loss of volatile compounds and a decrease in the intensity of certain pigments due to prolonged exposure to heat and UV radiation.

Shade drying is another method used, particularly for more delicate materials that may degrade when exposed to direct sunlight. By drying plant materials in the shade, such as under a tree or in a well-ventilated area, the pigments are less likely to fade, and the risk of thermal degradation is minimized. This method preserves the color intensity of the plant material, although it may take longer for the moisture content to be reduced.

Controlled drying chambers offer the most precise method for drying plant materials, especially in a commercial setting. These chambers allow for the regulation of temperature, humidity, and airflow, ensuring optimal drying conditions that prevent the degradation of sensitive pigments. Controlled drying also helps to prevent the growth of mold or bacteria, which can occur in high humidity conditions. In this method, plant materials are dried uniformly, preserving both the quality and the quantity of the colorants. The dried materials can then be stored for longer periods, ready for extraction when needed.

The moisture content of the plant material is carefully monitored during the drying process. Too much moisture remaining in the material can cause the dye compounds to degrade, while insufficient moisture content can lead to brittleness, making extraction more difficult. After drying, plant materials are often stored in sealed containers or bags to prevent moisture absorption and to keep the dyes intact for future use. The drying process is an essential step that ensures the plant material's colorant properties are preserved, enabling the effective production of high-quality plant-based dyes (Cardon, 2007).

Extraction of Dye Compounds

The dye is typically extracted by boiling the plant material in water to release the pigments. The extraction process may vary depending on the type of plant and the desired colorant. For example, anthocyanins (which produce red, purple, or blue colors) are usually extracted from berries or flowers through hot water extraction. Turmeric roots, on the other hand, release their yellow dye (curcumin) when boiled in water or alcohol. The extraction time and temperature are carefully controlled to maximize yield and ensure that the dye compounds are properly isolated (Gupta and Laha, 2007).

Purification and Concentration

After the dye is extracted from plant materials, the liquid is typically filtered to remove any solid plant debris, resulting in a clear, pure dye solution. This filtration step is crucial for eliminating unwanted particles that could affect the dye's quality and consistency. Once filtered, the liquid extract is concentrated through evaporation. The solution is gently heated to remove excess water, increasing the dye’s concentration and potency. This concentrated dye is easier to apply to fabrics or other materials. In some cases, solvents like alcohol are used during the extraction process to enhance pigment dissolution and improve the overall yield. Alcohol can dissolve certain pigments more effectively than water, ensuring a higher quality extract. It may also help purify the dye, removing impurities that could affect its color and stability. These techniques, including filtration, evaporation, and solvent use, ensure that the plant-based dye is both potent and pure, suitable for various industrial and artistic applications (Bechtold and Mussak, 2009).

Mordanting and Dyeing

After extraction, plant-based dyes are often treated with mordants, which are chemical agents that enhance the dye's ability to bond with fibres, ensuring better color fastness and overall durability. Mordants help the dye adhere more firmly to the material, preventing it from fading or washing out easily. Common mordants include alum, iron, and tannins. These mordants can be derived from both plant-based sources and minerals. For example, alum is a widely used mordant for bright, clear colour, while iron can create more muted or darker tones. Tannins, often found in plant sources like oak galls or sumac, help intensify the color and improve the dye’s fixation. After mordanting, the textile or material is immersed in the dye bath for a predetermined amount of time, allowing the dye to penetrate the fibres and achieve the desired color intensity. This process significantly enhances the longevity and vibrancy of the final dyed product, making the colours more resistant to fading over time (Sarkar and Mazumder, 2015).

Storage and Use

The final dye extracts can be stored for later use or immediately applied to fibres and fabrics. The storage method may include refrigeration or freezing to preserve the dye for extended periods. When in use, plant-based dyes can provide a wide range of colours, from vibrant hues to more subdued tones, depending on the plant material and extraction technique (Cardon, 2007).

The collection and isolation of plant-based dyes is an intricate process that combines traditional knowledge with modern techniques to extract the maximum potential of plant pigments. Innovations in this area, including biotechnological advancements and the use of eco-friendly mordants, continue to make the extraction process more sustainable and efficient, making plant-based dyes a viable alternative to synthetic dyes.

Role of AI Plant based dye production

Artificial Intelligence (AI) is becoming a transformative force in the plant-based dye production industry, enabling more efficient and sustainable practices. AI-driven algorithms are being used to optimize extraction processes, predicting the best parameters such as temperature, time, and solvent concentration to maximize dye yield while minimizing resource consumption (Banerjee and Ghosh, 2019). Furthermore, AI models can forecast the color properties of dyes by analyzing

the chemical composition of plant materials, helping manufacturers achieve consistent and vibrant results (Sharma and Gupta, 2021). In addition to improving extraction and color prediction, AI is also facilitating automation in the dyeing process, ensuring precise application and better-quality control through machine learning and computer vision technologies (Yu and Li, 2022). This has led to reduced defects and more uniform coloration in dyed fabrics (Sinha and Gupta, 2018). Through these innovations, AI not only enhances the efficiency of plant-based dye production but also supports sustainability by reducing waste, energy use, and the environmental impact of synthetic alternatives (Ahmed and Jameel, 2020).
Applications of Plant dyes in various industries

Textile Industry

The textile industry is one of the largest consumers of plant-based dyes, particularly in sustainable fashion and traditional crafts. These dyes are commonly used to color fabrics such as cotton, silk, and wool, with techniques like hand-dyeing, batik, and tie-dye enhancing the uniqueness of each product. Artisanal textile producers often use indigo for deep blues, madder for earthy reds, and turmeric for vibrant yellows. Additionally, eco-conscious brands are increasingly adopting plant-based dyes to align with their sustainable values, marketing their products as eco-friendly and ethical. Innovations in mordanting techniques, like the use of bio-mordants derived from tannins, are helping to improve the fastness and vibrancy of these dyes, making them more competitive with synthetic alternatives (Bechtold and Mussak, 2009).

Cosmetics Industry

In the cosmetics sector, plant-based dyes are integral to creating natural beauty products. Henna remains a staple for hair dyeing, offering a chemical-free way to achieve rich orange-red tones while conditioning the hair. Turmeric is not only valued for its bright yellow color but also for its skin-healing and anti-inflammatory properties, making it a popular ingredient in face masks and creams. Beetroot is used to provide a natural reddish hue in lip balms and cheek tints, while pigments from berries and flowers are being explored for creating a broader spectrum of cosmetic shades. These dyes cater to growing consumer demand for organic and cruelty-free beauty products, contributing to the expansion of the clean beauty movement (Sarkar and Mazumder, 2015).

Food Industry

The food industry utilizes plant-based dyes for their dual role as colorants and health-enhancing agents. Anthocyanins, found in berries and purple vegetables, provide rich purple and blue shades, while betalains from beets create vibrant reds and yellows. Carotenoids, present in carrots, tomatoes, and peppers, produce a range of yellow, orange, and red tones. These dyes are used in beverages, candies, yogurts, and bakery products, meeting the rising consumer demand for natural food additives and clean-label products. Moreover, many of these dyes come with added health benefits, such as antioxidant and anti-inflammatory properties, enhancing the nutritional profile of the food products they color (Gupta and Laha, 2007).

Art and Craft Sector

Plant-based dyes also play a vital role in traditional and contemporary art forms. Artists and craftspeople use them to dye natural fibres, create handmade paper, and paint on various surfaces. The use of plant-based dyes adds a unique texture and depth to artwork, while their biodegradable nature ensures minimal environmental impact. For example, walnut husks are used for rich brown inks, and marigold flowers are used to create bright yellow paints (Cardon, 2007).

Biomedical and Pharmaceutical Applications

The biomedical field is exploring the potential of plant-based dyes beyond aesthetics. Many of these natural pigments exhibit antimicrobial, antioxidant, and anti-inflammatory properties, making them valuable in wound care and drug delivery systems. For instance, curcumin, derived from turmeric, is being studied for its therapeutic potential in cancer treatment and as an anti-inflammatory agent. Chlorophyll, extracted from green plants, is used in bio-imaging and as a natural antimicrobial agent. Advances in biotechnology are enabling researchers to extract and optimize these pigments for use in advanced healthcare applications, such as biocompatible coatings for medical devices (Bechtold and Mussak, 2009).

Environmental and Educational Uses

Plant-based dyes are also gaining traction in environmental and educational contexts. Workshops and educational programs often use natural dyes to teach about sustainability and traditional practices. These dyes are used in community projects to promote eco-friendly initiatives, such as upcycled textiles and environmentally conscious art. The increasing applications of plant-based dyes across these sectors underscore their versatility and growing relevance in a world striving for sustainability. With advancements in technology and an increasing focus on reducing environmental impact, the role of plant-based dyes is likely to expand, providing eco-friendly solutions to modern challenges (Sarkar and Mazumder, 2015).

Conclusion

Plant-based dyes present a viable and sustainable alternative to synthetic colorants in multiple industries, including textiles, cosmetics, food, art, and biomedical applications. Their non-toxic, biodegradable nature, along with the growing consumer demand for natural products, makes them increasingly relevant in today's eco-conscious market. Although challenges such as inconsistent color fastness and resource limitations exist, technological advancements, including the use of AI and eco-friendly mordants, are improving the efficiency and sustainability of the dyeing process. These developments not only enhance the performance of plant-based dyes but also foster a deeper appreciation for traditional dyeing techniques, further supporting sustainability goals. As research progresses, the potential of plant-based dyes to become a cornerstone of eco-friendly solutions across industries is evident, contributing to a healthier, more sustainable future.

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SMART FABRICS REDEFINED: LEVERAGING AI FOR ADAPTIVE, INTELLIGENT, AND SUSTAINABLE TEXTILES

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ABSTRACT

Artificial Intelligence (AI) has the potential to revolutionize the textile industry by enabling the development of smart fabrics with adaptive capabilities. This paper explores the use of machine learning to identify and blend materials, combined with neural networks to train models Advanced materials such as Phase-Changing Materials (PCMs), which regulate temperature by changing their state from solid to liquid and vice versa, and Shape-Memory Polymers (SMPs), which alter their shape in response to heat, light, or humidity, play a crucial role in achieving adaptability. Additionally, AI-driven decision-making allows algorithms to analyze data from embedded sensors and make real-time adjustments. This integration of advanced materials and AI technologies offers the potential for enhanced functionality, improved comfort, and greater sustainability in textile applications....

Keywords: AI - Driven Decision making , Phase -Changing Materials (PCMs), Neural Network,Shape-Memory Polymers (SMPs).

INTRODUCTION

The integration of Artificial Intelligence (AI) into the textile industry has paved the way for the development of smart fabrics, a transformative innovation poised to redefine the role of textiles in modern society. Unlike traditional fabrics, smart textiles combine advanced materials, embedded sensors, and AI-driven technologies to offer dynamic adaptability, making them highly functional, intelligent, and sustainable. These fabrics are designed to autonomously respond to environmental conditions such as temperature, humidity, and physical activity, enhancing comfort, usability, and efficiency.

The backbone of this innovation lies in the synergy between advanced materials and AI. Phase-Changing Materials (PCMs) enable temperature regulation by transitioning between solid and liquid states, while Shape-Memory Polymers (SMPs) alter their structure in response to stimuli like heat and light. Embedded sensors collect real-time data, which is analyzed by AI algorithms to predict and execute appropriate adaptations. For instance, AI processors embedded within the fabric allow real-time decision-making, empowering the fabric to autonomously adjust its properties for optimal performance.

Beyond functionality, smart fabrics address sustainability by optimizing material usage, reducing waste, and extending product life cycles. They hold immense potential across various sectors, including healthcare (e.g., monitoring vital signs), sportswear (e.g., enhancing performance), and fashion (e.g., customizable clothing). Furthermore, these fabrics can play a pivotal role in creating eco-friendly solutions by reducing energy consumption and offering innovative recycling mechanisms.This research aims to explore the design and development of smart fabrics using AI, focusing on the creation of adaptive textiles capable of intelligent real-time responses to their surroundings. The paper underscores the transformative potential of smart fabrics to revolutionize industries, enhance everyday experiences, and contribute to a sustainable future.

LITERATURE REVIEW

1. Heitor Luiz Ornaghi and Roberta Motta Neves (2022) discuss the recent advances and challenges regarding smart fabric textiles. The possibilities of innovative smart textiles extending the overall usefulness and functionalities of standard fabrics are immense in the fields of medical devices, fashion, entertainment, and defense, considering sufficient comfort as a parameter necessary for users to accept wearable devices.

2.Ankush Biswas, Ananya Jana (2024) examines the valuable insights into the transformative potential of smart fabrics and their role in shaping the future of wearable technology and beyond. E-textiles, which seamlessly integrate electronics and textile materials, offer innovative solutions for wearable technology, smart garments, and functional textiles. Furthermore, it examines various application areas of e-textiles.

3.Ruth Strand and Johan Berglund (2020):In their research, the authors delve into the integration of embedded sensors and microelectronics within textiles to create intelligent fabrics capable of monitoring environmental and physiological parameters. The study underscores the potential of smart fabrics in healthcare, especially in real-time monitoring of patient vitals, but also identifies challenges in energy efficiency and scalability.

4.Zhou et al. (2022):A comprehensive analysis of the sustainability challenges in smart textiles is provided, focusing on the use of eco-friendly materials and energy-efficient systems. The authors emphasize the importance of combining functionality with sustainability to reduce the environmental impact of these advanced fabrics.

5.Mishra et al. (2021):The authors investigate the challenges of power management in smart fabrics, proposing innovative energy-harvesting solutions such as flexible solar panels and kinetic energy systems. Their findings underscore the necessity of integrating self-sustaining power sources into autonomous fabrics for seamless functionality.

EXISTING SYSTEM

Current smart fabric systems leverage embedded sensors, advanced materials, and IoT technology to enhance the functionality of traditional textiles.While they are not fully autonomous or adaptive to all environmental conditions, they provide a foundation for developing more advanced systems. Below are key examples of existing systems:

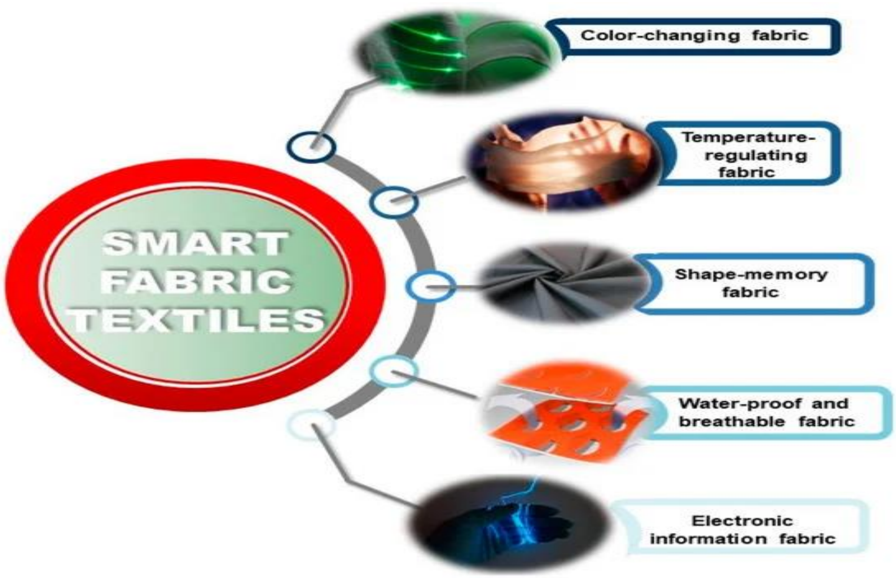
1. Wearable Health Monitoring Fabrics

- **Description:** These systems use embedded sensors to monitor vital signs such as heart rate, body temperature, and respiration.

- **Example:** Hexoskin smart shirts integrate ECG sensors to track heart rate and breathing patterns, transmitting data to connected devices for analysis.
- **Limitations:**
  - Focus is primarily on data collection and transmission rather than real-time adaptation.
  - Limited to specific applications like fitness or healthcare.

2. Light-Responsive Textiles

- **Description:** Fabrics embedded with **photochromic materials** change color or transparency based on light intensity.
- **Example:** Materials used in fashion and accessories to create dynamic visual effects.
- **Limitations:**
  - Focus on aesthetics rather than functionality.
  - Lacks integration of sensors or decision-making capabilities.



3. Sportswear with Moisture Management

- **Description:** These fabrics incorporate hydrophilic and hydrophobic layers to manage sweat and improve breathability during physical activity.
- **Example:** Nike Dri-FIT and Adidas Climacool technology enhance performance by wicking moisture away from the body.
- **Limitations:**
  - Pre-defined functionality without adaptability.
  - No AI-driven analysis or real-time response.

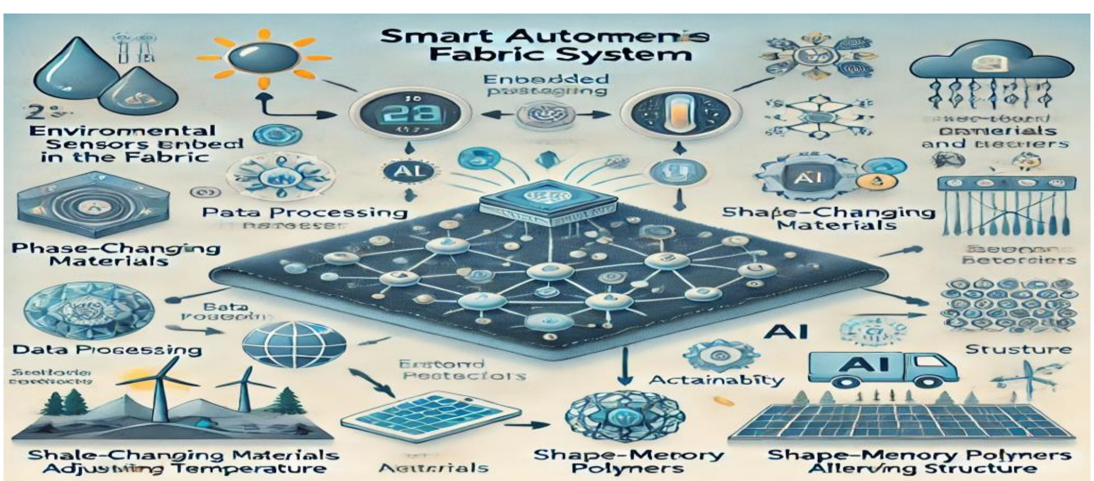
4. IoT-Connected Smart Fabrics

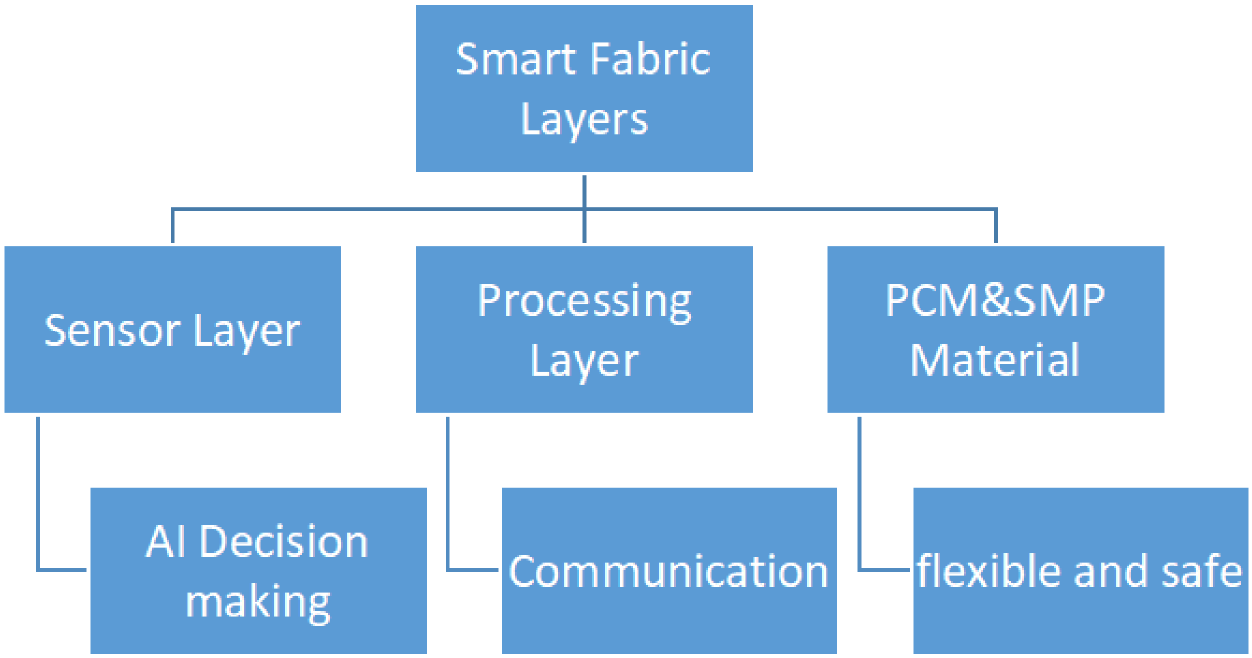
- **Description:** Fabrics embedded with sensors and IoT modules communicate data to smartphones or cloud systems for analysis and feedback.
- **Example:** Levi's Jacquard Jacket integrates touch-sensitive threads to control devices like phones through gestures.
- **Limitations:**
  - Interaction is user-driven rather than autonomous.

PROPOSED SYSTEM

The proposed system integrates smart materials, embedded sensors, and AI-driven processing to develop autonomous fabrics that dynamically adapt to environmental conditions. This system operates through three interconnected layers. The sensing layer collects real-time environmental and user-specific data using embedded sensors, including temperature sensors to detect ambient and body temperature changes, humidity sensors to monitor moisture levels, and motion sensors to track physical activity. This data serves as input for decision-making processes. The processing layer leverages machine learning and neural networks to analyze the sensor data and make real-time decisions. An AI processor, such as an embedded microcontroller like Raspberry Pi or Arduino Nano BLE Sense, processes the data, while pre-trained neural networks predict the fabric's responses based on environmental conditions and user activity. This layer ensures adaptive decision-making, determining necessary adjustments in fabric properties like thermal regulation and ventilation.

The adaptive layer implements the required adjustments using smart materials and actuators. Key components include Phase-Changing Materials (PCMs) for temperature regulation through state changes (solid to liquid and vice versa) and Shape-Memory Polymers (SMPs) that alter their structure to modify fit, ventilation, or insulation. Actuators drive these changes in response to AI commands, enabling real-time adjustments such as increasing breathability during physical activity or providing insulation in cold environments. The system also incorporates wireless connectivity via Bluetooth or Wi-Fi for external communication with devices like smartphones, allowing customization and monitoring. Energy requirements are addressed through flexible rechargeable batteries or energy-harvesting methods like solar panels and kinetic energy.





The overall workflow begins with sensors detecting environmental and user-specific parameters. Collected data is transmitted to the AI processor, which analyzes it and determines the necessary adjustments. Actuators and smart materials then implement these changes in real-time. By seamlessly integrating smart materials and AI, this system allows fabrics to autonomously adapt to environmental changes, delivering enhanced comfort, functionality, and sustainability.

CONCLUSION

The proposed smart autonomous fabric system represents a significant advancement in textile technology, leveraging the synergy of embedded sensors, Artificial Intelligence (AI), and advanced materials to create fabrics that can dynamically adapt to environmental and user-specific conditions. By incorporating innovative components such as Phase-Changing Materials (PCMs), Shape-Memory Polymers (SMPs), and AI-driven decision-making, the system offers a transformative solution for achieving real-time adaptability, enhanced functionality, and sustainability in textiles.

This paper addresses critical gaps in existing systems by enabling autonomous behavior, real-time adjustments, and sustainable practices through energy-efficient designs and eco-friendly materials. The seamless integration of sensing, processing, and adaptive layers ensures that the fabric can provide personalized comfort, optimal performance, and reduced environmental impact, making it ideal for applications in healthcare, sportswear, fashion, and environmental monitoring.

In conclusion, this project not only highlights the potential of AI and smart materials in redefining the textile industry but also lays the foundation for a new era of intelligent, responsive, and sustainable fabrics that align with the needs of a rapidly evolving world.

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VIRTUAL FASHION DESIGNING

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Abstract

Artificial Intelligence (AI) has emerged as a revolutionary force in the fashion industry, significantly influencing virtual fashion designing and digital garment prototyping. AI's ability to automate intricate processes, enhance creativity, and minimize resource consumption has redefined traditional fashion design and production paradigms. Through advanced tools such as machine learning algorithms, computer vision, and generative design, AI enables designers to create precise, innovative, and sustainable virtual prototypes. These technologies streamline the design process by simulating fabric behavior, optimizing material layouts, and offering real-time feedback, thereby reducing the dependency on physical samples.

This article delves into the transformative role of AI in digital garment prototyping, highlighting its methods, benefits, and broader implications for designers, manufacturers, and the environment. AI-driven virtual prototyping has demonstrated significant advantages, including accelerated time-to-market, cost reductions, enhanced creative freedom, and alignment with global sustainability goals. The integration of AI not only fosters operational efficiency but also addresses pressing environmental concerns by minimizing textile waste and resource use.

Case studies featured in this article showcase successful implementations, such as the use of CLO 3D, which has led to substantial cost savings, reduced prototyping iterations, and improved design accuracy. These examples underscore AI's potential to revolutionize the fashion industry, making it more adaptive, inclusive, and environmentally conscious. As AI technologies continue to evolve, their integration into fashion design promises to redefine creativity, sustainability, and consumer engagement on a global scale.

Keywords: Artificial Intelligence, Digital Garment Prototyping, Virtual Fashion, Fashion Technology, Sustainable Design

Introduction

The fusion of technology and fashion has given rise to groundbreaking advancements, with artificial intelligence (AI) at the forefront. Traditional garment prototyping, a resource-intensive process involving multiple iterations, is now being revolutionized by AI-powered virtual techniques. Digital garment prototyping leverages AI algorithms to create, test, and modify designs in a virtual environment, reducing time, cost, and waste. This article examines the methods and outcomes of AI-driven prototyping, emphasizing its impact on creativity, efficiency, and sustainability.

AI-driven digital prototyping uses advanced software and machine learning algorithms to simulate fabric draping, pattern fitting, and design aesthetics in three-dimensional (3D) environments. These virtual tools enable designers to visualize garments more accurately than ever before, allowing them to make precise adjustments before producing physical samples (Lu & Smith, 2023). Such innovations have streamlined the development process by minimizing errors and reducing dependency on physical prototypes, leading to significant cost savings and faster production cycles.

One of the key advantages of AI-powered prototyping is its ability to enhance creativity. Designers can experiment with complex patterns, textures, and silhouettes that would be difficult to conceptualize through traditional methods. AI tools also provide predictive analytics, helping designers anticipate trends and consumer preferences, which supports the creation of market-ready products (Kim, 2022). Furthermore, generative design algorithms empower creators to explore unconventional ideas, pushing the boundaries of fashion design.

Efficiency is another crucial benefit. By automating repetitive tasks such as pattern grading and size adjustments, AI reduces manual labor and accelerates the development process (Chen et al., 2023). Virtual prototyping platforms facilitate seamless collaboration among global teams, allowing designers, manufacturers, and stakeholders to review and refine designs in real time.

Sustainability has become a central concern in modern fashion, and AI-driven prototyping offers promising solutions. By minimizing fabric waste and optimizing material usage, virtual prototyping aligns with sustainable practices (Jones & Taylor, 2023). It also reduces the carbon footprint associated with physical shipping and production, supporting the industry's shift toward environmentally responsible methods.

AI-driven digital garment prototyping is reshaping the fashion industry by enhancing creativity, improving efficiency, and promoting sustainability. As AI technology continues to evolve, its role in transforming design processes and reducing environmental impact will only expand. Future research should explore deeper integrations of AI with augmented reality (AR) and virtual reality (VR) to further innovate fashion design.

Methods

1. **AI Tools and Technologies**
   - **Machine Learning Algorithms:** AI-driven software such as CLO 3D and Optitex harness machine learning to optimize design workflows. These algorithms predict how fabrics behave under different conditions by analyzing vast datasets of fabric properties and construction details. This capability allows designers to foresee potential issues and refine their designs before creating physical prototypes, saving both time and resources (Clo Virtual Fashion, 2024; Optitex, 2023). Additionally, machine learning tools provide suggestions for layout optimization, enhancing efficiency in material usage (Smith & Taylor, 2023).
   - **Computer Vision:** Computer vision technologies enable designers to visualize garments on digital avatars with remarkable accuracy. This capability allows for precise fitting simulations, ensuring that designs are both functional and aesthetically pleasing. Computer vision employs advanced image recognition to map fabric textures and movements, making it possible to simulate drape and style in real-time (Zhang & Lee, 2022). These tools are instrumental in creating inclusive

designs, as they can generate avatars of diverse body types and sizes, ensuring that garments cater to a broader audience (Williams, 2022).

- **Generative Design:** Generative design involves the use of algorithms like Generative Adversarial Networks (GANs) to create innovative patterns and styles. GANs work by analyzing existing datasets of designs and then generating new outputs that blend or extrapolate from the input data. This approach enables designers to explore unconventional aesthetics and push creative boundaries. For instance, GANs have been used to generate unique fabric patterns that would be challenging to conceptualize manually (Zhang & Lee, 2022). Furthermore, generative design can adapt styles to meet emerging trends or cultural nuances, making it a valuable tool for global fashion markets (Smith & Taylor, 2023).

2. **Digital Workflow Integration**
    - **Virtual Sampling:** Designers use AI platforms to create 3D garment simulations, eliminating the need for physical samples during the initial stages.
    - **Real-Time Feedback:** AI systems provide instant insights into design elements like texture, color, and drape, allowing immediate refinements.
3. **Collaboration and Customization**
    - **Collaborative Platforms:** AI enables teams to work remotely, sharing designs in real-time through cloud-based tools.
    - **Customer Personalization:** AI tailors designs to individual preferences by analyzing consumer data and trends.

Results

The application of AI in digital garment prototyping has demonstrated significant benefits:

1. **Time Efficiency:** Virtual prototyping significantly accelerates the design-to-market cycle. Traditional methods often require several months of iterative prototyping, but AI-powered systems like CLO 3D can reduce this timeline by 30-50%. By simulating multiple fabric types, fits, and patterns in minutes, designers can finalize their concepts faster without compromising quality (Clo Virtual Fashion, 2024). This efficiency is particularly advantageous in fast fashion, where speed to market is critical (Smith & Taylor, 2023).
2. **Cost Reduction:** AI-driven virtual prototyping helps manufacturers cut costs by minimizing the need for physical samples. Studies show a 40% reduction in material expenses due to fewer iterations (Optitex, 2023). Moreover, the elimination of manual errors in design ensures less wastage of high-cost fabrics (Williams, 2022). By automating routine tasks like pattern adjustments, companies save on labor costs while enhancing precision (Zhang & Lee, 2022).
3. **Sustainability:** The environmental benefits of AI in fashion are significant. Digital garment prototyping drastically reduces textile waste generated during sample creation. By creating virtual samples, brands align with eco-friendly practices and meet consumer demands for sustainable fashion (Smith & Taylor, 2023). Furthermore, AI can optimize fabric usage in layouts, ensuring minimal leftover material (Williams, 2022). This aligns with global efforts to reduce the carbon footprint of the textile industry.
4. **Enhanced Creativity:** With AI, designers can explore complex patterns and structures that might be challenging to realize through traditional methods. Generative design tools allow experimentation with intricate textures and unconventional silhouettes (Zhang & Lee, 2022). By removing the physical constraints of prototyping, designers gain freedom to innovate and redefine fashion aesthetics (Clo Virtual Fashion, 2024). For example, AI tools

have been instrumental in creating avant-garde collections that push the boundaries of wearable art (Smith & Taylor, 2023).

Case Study: CLO 3D Implementation

A mid-sized apparel brand implemented CLO 3D to enhance its prototyping process. Over six months, the brand experienced remarkable improvements in operational efficiency. Production costs were reduced by 45%, attributed to a significant decrease in the need for physical prototypes and wastage of high-value fabrics (Clo Virtual Fashion, 2024). By leveraging CLO 3D's ability to simulate multiple iterations in a digital environment, the company achieved a 60% reduction in prototype iterations. This not only accelerated the design-to-market process but also fostered greater collaboration among design teams (Smith & Taylor, 2023).

Stakeholders provided overwhelmingly positive feedback on the improved accuracy and visualization of garment designs. CLO 3D's realistic simulations allowed for precise fitting and styling, which translated to higher satisfaction among clients and partners (Williams, 2022). Additionally, the use of digital avatars enhanced inclusivity by enabling the design of garments for diverse body types (Zhang & Lee, 2022). This case underscores the transformative potential of AI in modern fashion design, offering a blueprint for other apparel brands aiming to innovate sustainably.

Conclusion

AI is revolutionizing virtual fashion designing by enabling efficient, sustainable, and innovative digital garment prototyping. Through the integration of advanced tools like machine learning algorithms and computer vision, fashion designers can produce highly accurate virtual prototypes. These innovations not only reduce production timelines but also align with global sustainability goals by minimizing waste and resource consumption (Clo Virtual Fashion, 2024; Smith & Taylor, 2023).

The impact of AI extends beyond operational efficiency, fostering creativity and inclusivity. Generative design tools have opened new horizons for creative exploration, while digital avatars have enabled the creation of garments for diverse body types (Zhang & Lee, 2022). The adoption of AI has also proven economically beneficial for manufacturers, with significant reductions in labor and material costs (Williams, 2022).

Looking ahead, future advancements in AI, such as augmented reality (AR) integration and enhanced predictive analytics, will further transform the fashion industry. AR could enable consumers to virtually try on clothes, while predictive analytics can refine inventory management by forecasting consumer trends with greater accuracy (Smith & Taylor, 2023). The continuous development of these technologies will strengthen the connection between designers, manufacturers, and consumers, driving the industry toward a more sustainable and innovative future (Optitex, 2023).

As AI continues to evolve, its role in the fashion industry will expand, offering unprecedented opportunities for growth and sustainability. By embracing these advancements, the fashion industry can address environmental concerns and adapt to rapidly changing consumer demands, securing its place in the digital age (Clo Virtual Fashion, 2024; Zhang & Lee, 2022).

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EXPLORING THE IMPACT OF AI-DRIVEN TECHNOLOGIES ON SUSTAINABLE BUSINESS PRACTICES AND LOYALTY AMONG MILLENNIALS WITH RESPECT TO ONLINE STORES IN TRICHY CITY

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ABSTRACT

Artificial Intelligence (AI) has transformed various sectors, including e-commerce, with technologies like personalized recommendations and eco-friendly packaging, enhancing customer experiences and promoting sustainable practices. This study explores the impact of AI on sustainability and customer loyalty among millennials, focusing on online stores in Trichy City. Using an exploratory research design, the primary data was collected from 150 millennials and analysed through descriptive and inferential statistical techniques.

The findings show that "Eco-friendly Packaging" and "Personalized Recommendations" are the most valued AI technologies for sustainability, while "Inventory Optimization" is less important. Millennials generally perceive these technologies positively in terms of sustainability. The study identifies strong positive relationships between AI-driven technologies, sustainability, and customer loyalty, with a stronger link to sustainability practices. Multiple regression analysis confirms that AI technologies, particularly eco-friendly packaging, significantly influence sustainability in online stores.

Based on these findings, online stores should focus on integrating AI technologies like eco-friendly packaging and personalized recommendations to improve sustainability and loyalty. This study provides insights into AI's role in e-commerce sustainability and offers practical guidance for managers to align business practices with millennial expectations.

KEY WORDS: AI-driven Technologies, Sustainable Business Practices, Loyalty, Millennials, Online Stores

INTRODUCTION

In recent years, Artificial Intelligence (AI) has transformed many business sectors, including e-commerce. AI-driven technologies, such as personalized recommendations and eco-friendly packaging, have become important tools for improving customer experiences and business operations. These technologies help businesses run more smoothly and also support sustainable practices. By using AI-driven solutions, companies can reduce their environmental impact, use resources more efficiently, and achieve sustainable growth. This trend is especially noticeable in e-commerce, where businesses strive to balance making profits with being socially and environmentally responsible. This aligns with Sustainable Development Goal (SDG) 12, which aims to ensure sustainable consumption and production patterns by promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services and green jobs (United Nations, n.d.).

This study explores how AI-driven technologies affect sustainable business practices and customer loyalty among millennials, focusing on online stores in Trichy City. Millennials, (born between 1981 and 1996) known for their tech-savvy and environmentally conscious attitudes, form a large part of online shoppers. They tend to support brands that prioritize sustainability and use advanced technologies to enhance their shopping experiences. By looking at the connection between AI-driven technologies, sustainable business practices, and customer loyalty, this research aims to provide insights into how e-commerce businesses can meet the preferences and expectations of millennial consumers.

LITERATURE REVIEWS

Numerous studies have underscored the importance of sustainability and its outcomes across various sectors, focusing on the integration of AI-driven technologies. Cosgrove and Loucks (2015) talked about global water issues, focusing on the availability, quality, and cost of water. Mejías, Paz, and Pardo (2016) looked at sustainable practices in supply chains, showing how AI can help make operations more eco-friendly. Schaltegger, Hansen, and Lüdeke-Freund (2016) suggested that AI can transform business models by making them more efficient and innovative, which supports sustainability.

Further research has shown the key role of continuous innovation and AI in improving sustainability in different industries. Madonsela, Mukwakungu, and Mbohwa (2017) showed how AI and innovation can make the South African steel industry more sustainable. Arora et al. (2018) discussed how AI can solve environmental problems. Sanchez-Planelles, Segarra-Oña, and Peiró-Signes (2020) created a framework for corporate sustainability, highlighting AI's potential to promote sustainable business models. Nguyen and Pervan (2020) found that consumers trust brands more when they act ethically and focus on sustainability.

Recent studies continue to explore AI's impact on sustainability. Roque et al. (2021) showed how AI can manage waste and support a circular economy. Sierra and Suárez-Collado (2021) discussed sustainability challenges in developing countries and the need for innovative solutions. Kumar, Prakash, and Kumar (2021) found that consumers prefer brands committed to sustainability, which boosts brand loyalty. Other studies, like those by Tsolakis et al. (2022) and Cavazza et al. (2023), explored AI in logistics and agriculture, showing its environmental benefits and potential for sustainable development. Overall, these studies show how AI can help businesses become more sustainable and build strong customer loyalty.

RESEARCH GAP

Despite extensive research on sustainability and the transformative role of AI across various sectors, there remains a significant gap in understanding the specific impact of AI-driven technologies on sustainable business practices and customer loyalty among millennials, particularly in the context of online stores in Trichy City. Existing studies have explored AI's role in logistics, water management, environmental geotechnics, and other areas, but there is limited research focusing on how AI technologies can foster sustainability and loyalty in e-commerce, especially among tech-savvy and environmentally conscious millennial consumers. This study aims to address this gap by examining how AI-driven solutions can enhance sustainable practices and build strong customer loyalty in the growing e-commerce market of Trichy City.

STATEMENT OF RESEARCH PROBLEM

Artificial intelligence (AI) is rapidly changing the e-commerce industry. However, combining AI technologies with sustainable business practices is challenging. Many online stores find it difficult to use AI solutions while also being environmentally and socially responsible. This is a significant issue because consumers, especially millennials, are demanding more transparency and sustainability from the brands they support. While AI can improve efficiency and customer satisfaction, its role in promoting sustainability and achieving sustainability goals, specifically Goal 12: Responsible Consumption and Production, is not fully understood. This knowledge gap makes it hard for e-commerce businesses to achieve both technological advancement and sustainability objectives.

The sub-variable, personalized recommendations use AI to suggest products based on customer preferences, helping to reduce waste by promoting more relevant purchases. Efficient delivery systems use AI to optimize logistics, which can lower fuel use and emissions. Eco-friendly packaging uses AI to create sustainable packaging solutions that have less environmental impact. Inventory optimization uses AI to manage stock levels better, reducing overproduction and waste. Understanding how these AI-driven technologies can support sustainable practices and contribute to achieving sustainability goals, particularly Goal 12: Responsible Consumption and Production, is crucial for e-commerce businesses to build strong customer loyalty and succeed in a market that values sustainability (United Nations, n.d.).

OBJECTIVES OF THE STUDY

The primary objectives of this study are to examine the impact of AI-driven technologies on sustainable business practices and customer loyalty among millennials in the context of online stores in Trichy City. Specifically, the study aims to identify how AI-driven solutions such as personalized recommendations, efficient delivery, eco-friendly packaging, and inventory optimization contribute to achieving sustainable business practices. Additionally, it seeks to understand the perception of millennial consumers regarding sustainability and their loyalty towards brands that adopt AI-driven sustainable practices.

METHODOLOGY ADOPTED

This study examines the AI-driven Technologies on Sustainable Business Practices and Loyalty among Millennials with respect to online stores in Trichy City. A total of 150 Millennials who are using online shopping were selected using convenient sampling. The study adopted exploratory research design and mixed research (both qualitative and quantitative) approach with cross-sectional study. The data were analysed using descriptive and inferential statistical techniques in line with the study's objectives and hypotheses.

DATA ANALYSIS AND RESULTS

MILLENNIALS' PERCEPTION ON IMPACT OF AI-DRIVEN TECHNOLOGIES FOR SUSTAINABILITY BUSINESS PRACTICES – MEAN ANALYSIS

The questionnaire comprised twelve questions addressing the Millennials Perception on the Impact of AI-driven Technologies on Sustainability Business Practices, with three questions dedicated to each sustainability business practice. These questions applied a "Five-point Likert scale", ranging from "Strongly Disagree (1) to Strongly Agree (5) and the same were measured through descriptive (Mean) analysis.

Table 1
MILLENNIALS' PERCEPTION ON THE IMPACT OF AI-DRIVEN TECHNOLOGIES FOR SUSTAINABILITY BUSINESS PRACTICES

MEAN ANALYSIS

AI-DRIVEN TECHNOLOGIES FOR SUSTAINABILITY BUSINESS PRACTICES	**N**	**Mean**	**SD**
Personalized Recommendations	150	11.86	3.521
Efficient Delivery	150	11.33	3.136
Eco-friendly Packaging	150	12.15	2.984
Inventory Optimization	150	10.28	3.897
MILLENNIALS' PERCEPTION ON THE IMPACT OF AI-DRIVEN TECHNOLOGIES FOR SUSTAINABILITY BUSINESS PRACTICES	**150**	**45.62**	**3.117**

(Primary-Data Source)

The findings of the above results revealed that "Eco-friendly Packaging" (M = 12.15) and "Personalized Recommendations" (M = 11.86) are the highest-rated sustainability business practices, while "Inventory Optimization" (M = 10.28) had the lowest score compared with others. Additionally, millennials' perceptions across all the four sustainability business practices were above average, with the overall mean score standing at 45.62 out of 60, equating to 76.03% of the total possible score. This indicates a high level of millennials' perceptions on the impact of AI-driven Technologies on Sustainability Business Practices.

CORRELATION ANALYSIS

H_0: There are no significant relationships among AI-driven Technologies, Sustainability Business Practices and Loyalty of millennials towards Online Stores.

TABLE 2
RELATIONSHIPS AMONG AI-DRIVEN TECHNOLOGIES, SUSTAINABILITY BUSINESS PRACTICES AND LOYALTY

VARIABLES	N	'r' VALUE	P - VALUE	RELATIONSHIP	REMARKS	
					SIGNIFICANT	RESULT
AI-driven Technologies & Sustainability Business Practices	150	0.754**	0.000	Positive	Significant	REJECTED
AI-driven Technologies & Loyalty	150	0.689**	0.000	Positive	Significant	REJECTED
Sustainability Business Practices & Loyalty	150	0.702**	0.000	Positive	Significant	REJECTED

(**Correlation is significant at 1%)

A Pearson product-moment correlation was conducted to examine the relationships between AI-driven technologies, sustainability business practices, and millennials' loyalty towards online stores. Since the p-values (0.000) are lower than the significance level (0.01) in all cases, the null hypothesis is rejected. The results show strong positive and significant correlations among the three variables. AI-driven technologies have a stronger relationship with sustainability business practices (r = 0.754) than with customer loyalty (r = 0.689). Additionally, sustainability business practices exhibit a significant correlation with customer loyalty (r = 0.702). Thus, AI-driven technologies, sustainability business practices, and customer loyalty are significantly interconnected in the context of online stores.

IMPACT OF AI-DRIVEN TECHNOLOGIES ON SUSTAINABILITY BUSINESS PRACTICES

MULTIPLE REGRESSION ANALYSIS

H_0: AI-driven Technologies have no significant influence on Sustainability Business Practices.

TABLE 3
IMPACT OF AI-DRIVEN TECHNOLOGIES ON SUSTAINABILITY BUSINESS PRACTICES
Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.984	.654		7.125	.000
	Personalized Recommendations	.290	.032	.310	7.115	.000**
	Efficient Delivery	.497	.026	.271	5.482	.000**
	Eco-friendly Packaging	.110	.049	.432	8.965	.000**
	Inventory Optimization	.387	.030	.183	2.132	.016*

Dependent Variable: SUSTAINABILITY BUSINESS PRACTICES

A multiple regression analysis was conducted to examine the impact of AI-driven technologies on sustainability business practices adopted by online stores. The results indicate that all four independent variables collectively have a significant impact on sustainability business practices, with an F-value of 473.219 and a p-value of 0.000, which is lower than the significance threshold of 0.01 and 0.05. The adjusted R-squared value of 0.743 suggests that 74% of the variance in sustainability business practices can be explained by the independent variables.

Among the four AI-driven technologies, "Eco-friendly Packaging" emerged as the most influential factor (0.432), while "Inventory Optimization" had the weakest influence (0.183). "Personalized Recommendations" (0.310) and "Efficient Delivery" (0.271) also significantly contribute to sustainability business practices, although their impact is less pronounced than that of "Eco-friendly Packaging." These findings suggest that AI-driven technologies, particularly eco-friendly packaging, play a crucial role in enhancing sustainability practices within online stores.

FINDINGS AND SUGGESTIONS

The mean analysis shows that "Eco-friendly Packaging" and "Personalized Recommendations" are the most valued AI-driven technologies for sustainable business practices, while "Inventory Optimization" is the least valued. Millennials have a high overall perception of the impact of these technologies on sustainability. There are strong positive relationships between AI-driven Technologies, Sustainability Business Practices, and Customer Loyalty, with a stronger connection between AI-driven Technologies and Sustainability Business Practices. Multiple regression analysis confirms that AI-driven Technologies significantly influence Sustainability Business Practices, with "Eco-friendly Packaging" being the most influential and "Inventory Optimization" the least. Overall, AI-driven Technologies are important for promoting sustainability in online stores.

To enhance the impact of AI-driven technologies on sustainable business practices and customer loyalty among millennials, online stores should focus on further integrating and optimizing AI solutions. They should enhance eco-friendly packaging and personalized recommendations, and also work on improving inventory optimization. Educating customers about the environmental benefits of their practices can help build stronger loyalty. Additionally, working with technology experts to innovate and apply new AI solutions can boost sustainability and efficiency.

CONCLUSION

This study shows that AI-driven technologies have a strong impact on sustainable business practices and customer loyalty among millennials in online stores in Trichy City. Eco-friendly packaging and personalized recommendations are highly valued, while inventory optimization needs more focus. The study's limitations include being based on data from one city and relying on self-reported answers. Future research should look at other cities and use different types of data. This study contributes to understanding how AI can improve sustainability in e-commerce. For managers, it provides insights on how to use AI to meet the expectations of millennial customers and enhance sustainability. Overall, AI has the potential to transform e-commerce by aligning business practices with sustainability goals and meeting the evolving preferences of millennial consumers.

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AN OVERVIEW OF A BLOCKCHAIN IN ACCOUNTING: A THEORTICAL PERSPECTIVE

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ABSTRACT

In accounting various numbers of transactions are recorded on daily basis in books of accounts which are maintained by a business through its ledger which includes assets, liabilities, equity, expenses and income which are financial transactions records. To verify these records to make sure it is accurate which we likely to follow the concept of double-entry accounting system through debit and credit entry at same time in case of triple-entry system the third entry will be recorded in Blockchain. Latterly with evaluation of technological advancement various revolutionary as emerged over an internet namely cryptocurrency and blockchain functions which has potential to replace 500 years old double entry system of book keeping since 2009 blockchain as ruled over old methodology of book keeping by implementing its functions through its application in the field of banking, financial markets, insurance, voting system leasing contracts and government services. Insite of its functionality it's been less explored.

Technological advancement through blockchain can create a digital evolution which recreates new ways of building business. Which as dual effect on people and business, this journal aims at providing general insight on blockchain technology used in accounting which as greater impact in creating accounting ecosystem with its implementation, impact, usage, working and case study. Which is transparent, verifiable, and acceptable in real time auditing practices.

Key words: Triple-entry system, Digital evolution, Technology, Implementation and Revolutionary.

INTRODUCTION

Blockchain innovation has power to change society to enhance competitiveness of urban technology has a very promising future for multiple businesses. Which has strong base data storage which can't be changed or altered stores transaction records known as block with public several databases known as "chain" which is connected through peer-to-peer nodes known as "digital ledger". Which works like spreadsheet where all can add data and view can't be altered which secures the data entered which saves both time and money. This are very useful in multiple industries like finance, supply chain, manufacturing etc. Blockchain has three principles of cryptography, decentralization and consensus. The steps in blockchain facilitates verification and traceability of multistep transaction which involves verification and traceability for each transaction hence reduces time consuming and expensive for third party verifications along with fund transfer it allows to buy and sell crypto currency such as Bitcoin which cannot be hacked.

Research Methodology

The study is made through analysis of various study made by scholars, research person with their publication this paper aims at providing general insight on Blockchain used in accounting through secondary method of data collection and also with reference from magazines, websites and publications. This paper covers Blockchain technology affecting accounting industry, working of block chain, advantages and disadvantages along with case study and its current status which provides scope for future improvements.

Objectives of the study

- ➔ To know the overview & impact of blockchain in accounting sector
- ➔ To find out working of blockchain technology in accounting.
- ➔ To study the various drawback and outcomes which as effect on society and business.

Review literature

Jun Dai; Miklos A. Varsarhelyi (2017) : Made an attempt to study on Towards Blockchain-Based Accounting and Assurance aims at how blockchain could enable a real-time, verifiable and transparent accounting ecosystem. Which has the potential to transform current auditing practices which results in more precise and timely automatic assurance system.

Ting Yu, Zhiwei Lin, Qingliang Tang (2018) : Gave an inputs on Blockchain: The introduction and its application in financial accounting which sheds light on the potential application on blockchain technology in financial accounting and its possible impacts on independent auditors and financial accounting.

Enrique Bonsn, Michaela Bednarova (2019) : Have examined on Blockchain and its implications for accounting and auditing which states blockchain technology and the extent to which it might transform the accounting system which has impact on both society and business.

Jana Schmitz, Giulia Leoni (2019) : The study on Accounting and auditing at the time of blockchain technology : a research agenda which discuss on professional sources are governance, transparency and trust issues in the blockchain ecosystem, blockchain-enabled continuous audits, smart contract applications and the paradigmatic shift in accounts and auditors roles.

Taitiana Garanina, Mikko Ratna, John Dumay (2022): They have examined on Blockchain in accounting research: Current trends and emerging topics. Which provides light on current trends, analyse with citation analysis through 153 academic papers from two ranked journal Association of Business schools (ABC) and social science research network (SSRN).

Working of Blockchain in accounting

Blockchain has power to replace old traditional method of double entry system which is distributed ledger record into triple entry transaction. In General ledger includes assets, liabilities, income and expenses recorded under debit and credit side of the same amount at same time in double entry accounting system. Whereas in third entry transaction will be on blockchain. In process of maintaining entry through human effort may lead to errors.

Assuming purchase of Motor bike with bitcoin. Purchase with public consensus verifies the transaction as legitimate. This transaction will enter blockchain with verification through digital signature and time-stamped this network creates identical hash on both the end and Motor bike deals end will be shared to public ledger.

Search in blockchain for identical hash will be performed by an auditor to identify the hash string if there is no matching hash there is a red flag for the auditor that data has been manipulated.

Blockchain effect on accounting industry

Smart contracts

Streamlining the task of accounting transactions are meet by fulfilling certain conditions which helps professionals and institutions to automate certain work regarding payroll and reconciliations of statements which are cost effective and avoids manual work and errors also helps against fraud.

Decentralized, Distributed Ledger Technology

The main idea of usage of blockchain is to eradicate middle men work where in manual work sending money from person to person as to go through bank which slowdowns the process while blockchain maintain security called Miners which acts on rule-based agreement.

Altering the transactions on the Blockchain

Data entered in blockchain are highly secured change in values effect the hash value which generated through string values which protects sensitive data which can't be altered which is greater contribution in technology to overcome the manual manipulation of transactions.

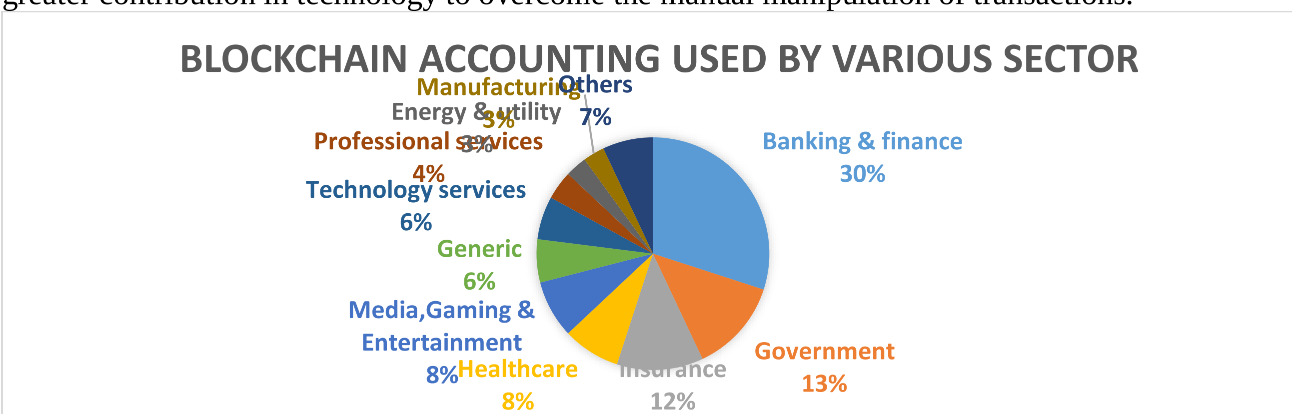

Fig No : 1 :- The above pie chart represent Blockchain used in Accounting by various sectors.

Blockchain Technology has greater influence in various sector which is represented through graphical representation through Pie chart In banking & finance 30% of blockchain software technology are used which is highest compared among all other sector whereas Manufacturing & Energy utility has lowest utilization of Blockchain Technology which is 3% , other sectors such as Insurance uses 12%, Healthcare 8%, Media , Gaming & Entertainment 8%, Generic 6%, Technology services 6% and professional services is 4% apart from this there are other various sector which uses 7%.

Advantages of blockchain in accounting

Highly transparent

The blockchain provides access to all parties to ledger data which helps in reducing fraud risks many industries beliefs high transparency benefits blockchain in accounting.

Secured security

Once data are entered can't be altered, forge, duplicate its highly difficulty to change the data entered by an unauthorized person in blockchain. study states data breach are reduced up to 80% in blockchain.

Reduction in expenses

Blockchain eliminated intermediaries hence many companies states that cost of middle person services is reduced with effective usage on blockchain.

Effective Auditing

Professionals and auditors can easily trace transactions which more accurate and reliable data and hash node acts a red flag for data tried for manipulation.

Drawbacks of blockchain in accounting

Latency

Time required for transaction to commit in blockchain domain is known as latency. Apparently, latency has significant compared to other e-payments such as VISA and Pay pal. Which grants 4.6 transactions per second. Were as other e-payments process 193 transactions per second on average.

Privacy leakage

Blockchain are meant for public which as huge accessibility which can adversely affect the information which are known for public even private keys are provided for crypto currency if key is lost funds cannot be withdrawn.

High cost of implementation

Company as to bear huge investment on installing blockchain needs to hire core developers for installing software's which cost sustainable funds addition to software hardware requirements are expensive.

Storage

All the information regarding transactions is shared across nodes on network where particular data are stored on hard drive of miner's system. Increase in data users the storage also expands.

Anonymity

Selling point in blockchain people may not able to track original seller which may result in money laundering and no one will be able to trace those transactions many cybercrimes are happening through blockchain money laundering platform.

Legal regulations

Blockchain faces many legal formalities which are regulated across the country's many laws are challenging which prohibits the usage of blockchain application.

Suggestions

- ➔ Blockchain will enhance professionalism in accounting which is accurate and transability which can be implemented in all the larger establishment for recording third entry transactions.
- ➔ It can be financial burden for startup and smaller and medium enterprise in purchasing software and they have to hire the data engineers for maintaining the blockchain. This can be solved if blockchain would come in cost effective for smaller enterprises.
- ➔ The entries are verified and entered with authentication the password and user Id login should be remembered of it may lead to loss the data and shares being held through cryptocurrency.
- ➔ It alerts the auditors through red flag if transactions are not matching since each transaction are encoded with hash code which can easily tracked.
- ➔ Even though the blockchain is secured the data or it can be hacked through hackers hence more secured password and technology required to be created.
- ➔ Implementation of Blockchain acts as a promising growth in various sector such as health, manufacturing, education, service, banking & insurance.

Conclusion

This paper aims at covering Working of blockchain and its advantage and limitations including suggestions. Some of the business feels blockchain technology are complex which can't be adopted in every business. Blockchain system are very helpful for maintain larger complex transactions which are accurate for third journal entries, Many MNC Such has Deloitte, pay pal & KPMG are adopting this technology for transactions of crypto currency and this are secured through hash were data once entered can't be changed many associations are working on legal, technical, finance and regulatory according to standards there are drawbacks such as privacy, hacking and environmental constraints which can be overcome through updating technology of blockchain.

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A STUDY ON EXTRACTION OF FIBRES FROM CURCUMA LONGA ROOT AND ANALYSE ITS CHARACTERISTICS FOR TEXTILE APPLICATION

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ABSTRACT

Usually, textile fibres are generalised as Natural and man-made fibres. In that natural fibres are extracted from the organic basis like plants, trees, shrubs, animals as well as natural minerals. On other hand, man-made, regenerated fibres are manufactured with the polymer molecules and extracted/reprocessed base from natural sources. Both the fibres are almost equally incorporated for the applications of textile but natural fibres are more requestable for the applications because of its eco-friendly nature, bio-degradability, wear comfort, minor/non-toxicity properties. Even though the synthetic fibre production is cheaper than the natural fibre-based fabric production, it creates huge impact to the environment as well as the consumers because its base material are chemical monomers and polymer crystals. Especially in textile industry, the processing of synthetic fibres, its processed waste disposal and the fabric leftovers are quite huge in range of volume. In textiles, these synthetic fibres are majorly implemented for the production of technical textiles because of its high tensile strength, fine thin structure, flexibility, and supportive properties. To provide an alternate source to these synthetic fibres, recycled natural sources and agro-industrial sources can compete with these polymer fibres and satisfy the required properties of applications. In that, technical textiles in form of non-woven composites are the major source to almost all possible industries for various applications. For those applications, synthetic fibres are widely in use but many alternatives of natural fibres are also tried to applied by some manufacturing industries and researchers from the recent past years. In this study, we choose some of the agro-industries residue fibres are selected and extracted to analyse its characteristics and properties to prepare samples for the technical textile applications.

Keywords: technical textiles, natural fibres, agro industrial residuals, fibre extraction, fibre characterization analysis, sustainable fibres

1. INTRODUCTION

Textile industry is the second largest one in the world market where food industry remains first. Both the textile industry and food industry have its production rate in a massive volume and once the production rate increase, the volume of its processed waste disposal also gets increase. Especially in food processing industries, residual disposal is likely equal to the production rate and its processed residues are disposed as landfill in major and some are burnt in land. Only few of the residues from the overall disposal gets converted as a recycled products or fertilizers. These waste disposals collected from the food processing industries can be collected from the food processing industries as well as cultivation land that may implemented in textile industry as a raw material to create a textile product of enhanced quality and limit the raw material purchase cost for production, which will create better demand in global textile market. In this study, some of food processing residues under the category of agro-industrial residues contain fibre quantity are selected and analysed to processed for textile application. Based on that this study carried out to collect and extract the fibre from one of the food based agro residual Curcuma Longa roots and its structure and characteristics are analysed.

Alternative fibres as Agro-industrial residues

Agro-residuals are the leftover part of the plants that collected during the process of cultivation, harvesting and also from poultry waste as well as the food processing residues. Implementation of agro-industrial residues in textile industry is not a new one as many of the sustainable fibres are in use, some of them are sugarcane bagasse, bamboo, banana, coir, Pina, lotus, orange, groundnut, corn, coffee ground, Siseal etc are the fibres incorporated for textile application. Fibres extracted from the agro-industrial residues doesn't need any specific sort of cultivation and its processing cost is comparatively lower than the usual textile virgin fibres. It considerably reduces the processing cost and also the volume of consumption of resources and waste disposal range that involves in both the industries.

2. MATERIALS AND METHODS

Selection of fibre

Curcuma Longa is generally termed as turmeric in world market, belongs to the family of ginger scientifically known as zingiberaceae. It is native to Southwest of India. Rhizomes of Curcuma longa being the source of bright yellow spice and also utilised as a dye stuff. These rhizomes are majorly used for food preservative and food colorant in cooking. Turmeric extracted from the rhizomes are prepared in tropical lands of all around the world but specially cultivated in India and South East Asia.

Properties and Application

Curcuma longa rhizomes are known as a golden resource for salutation purpose, used as a medicine for cold, cough, fever, nausea, stomach ache, act as a purifier of blood, treatment for liver complications, and inflammation, biliousness and jaundice, muscular disorder, biliary disorder, anorexia, diabetic wounds, hepatic disorders, rheumatism, and sinusitis etc and also it acts as a beautifier agent, cooking spice, textile, and industrial dye stuff. Curcuma longa have Anti-diabetic, Anti-bacterial activity, Anti-inflammatory, Anti-fungal activity, and Anti-viral activity etc.

Extraction process

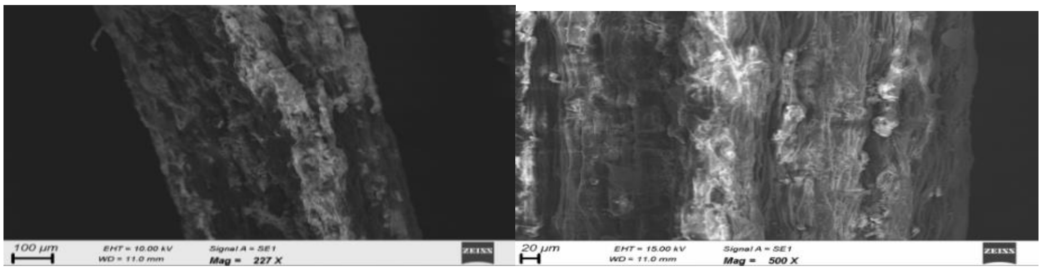
For the extraction of Curcuma longa fibres, first fibres that are accommodate in the rhizomes of Curcuma longa are isolated and then collected, and rinsed properly to sort according to its fibre length and quality. Collected fibres of 200gms are placed in a container or vessel filled with 1lit of water and remain soaked to 20 days for retting process. It is either allocated in air circulating area or addition of enzymes to speed up the retting process. In this process, microbes are formed and destroy the pulpy content from outer layer of fibre surface. After this retting process, fibres are rinsed properly to get dried and prepared for further process of production.

Characterization studies

Once the extraction processes are done, fibres are prepared for the characterization study like SEM, FTIR, XRD and TGA/DSC analysis to know its physical structure and chemical composition properties. SEM is conducted to analyse its surface structure and the position of cellulose and hemicellulose particles present in it. FTIR is conducted to analyse the chemical composition of fibre and its peak range. XRD is conducted to analyse the fibre crystallographic structure, physical and chemical properties present in it. TGA/DSC is conducted to analyse the thermal stability of the fibre and difference in rate of heat essential to increase in temperature. The resulted value of above-mentioned analysis test is detailed with the chart diagraph in the discussion part that mentioned below.

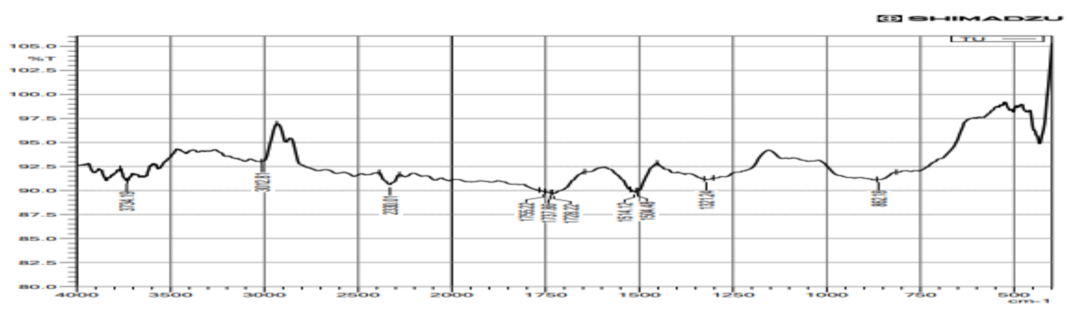
3. RESULT & DISCUSSION

SEM



Scanning Electron Microscopy is applied to examine the samples of scan with an electron beam to induce a magnified image of a sample for analysis. Sample analysis was conducted with the ZEISS SEM Analysis machine. Above mentioned pictures are Scanned Electron Microscopic image of Curcuma longa fibre with different angles of magnification. Above two pictures of samples are non-coated and scanned to analyse its structure. The surface morphology of curcuma longa fibres shows the cellular structure and these cells of fibres bond to form tissues connected at several places. The fibres have a long tubular structure and smooth surfaces with some nods and tufts at their entire length because of the presence of cellulose and hemicellulose particles of the fibres present in it. It consists of several molecules of other bodies, pectin, non-cellular, wax, cementitious substance. Fibres contain several nods and gaps that occurred due to the cuts and damages at the process of extraction of fibres. (Jenny Ngoc Tran Nguyen, Amanda M Harbison, 2017).

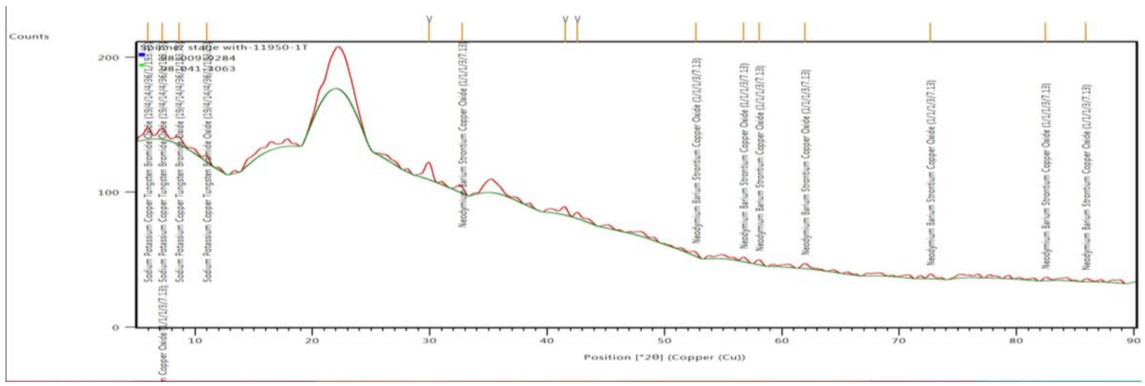
FTIR



FTIR spectrum is exploit to find out the functional group of varied components based on the peak value in the area of Infrared radiation. FTIR analysis for the Curcuma longa fibres are done with SHIMADZU analysis machine. In this FTIR analysis, fibres show almost similar value of peak points. Curcuma longa fibres contains properties of a functional group of O-H stretching vibration of broad peak at (3734.19) represent Alcohol, CH stretching bond peak at (3012.81) contain group of alkene, N-H bond of multiple broad peak at (2330.01) contain ammonium ions, C-H bond at (1755.22) Aldehyde present in cellulose and hemicellulose, A small band C = O stretching of ester groups (1737.86) N=O peak at (1728.22) contain group of Nitro (R-NO2), C-H bond peak at (1514.12) contain Alkene, C-H bond at peak

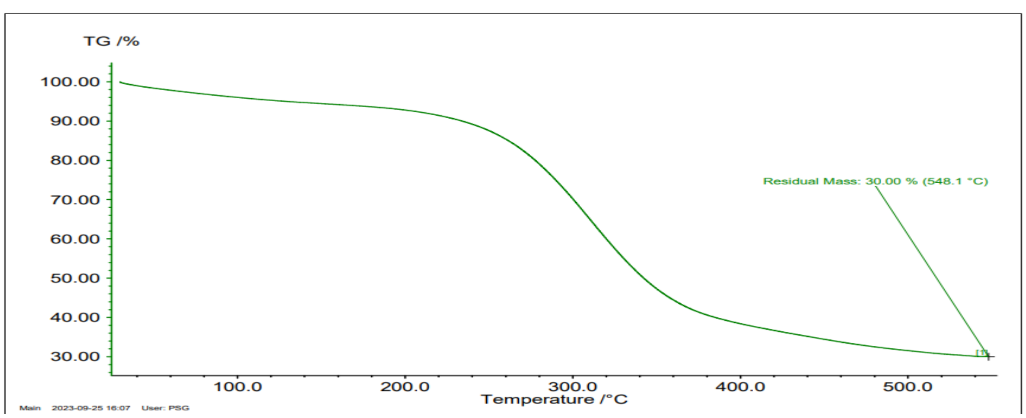
(1504.48) contain group of Aromatic particle, C-CI bond at peak (1321.24), (862.18) contain Halo compound in it.

XRD



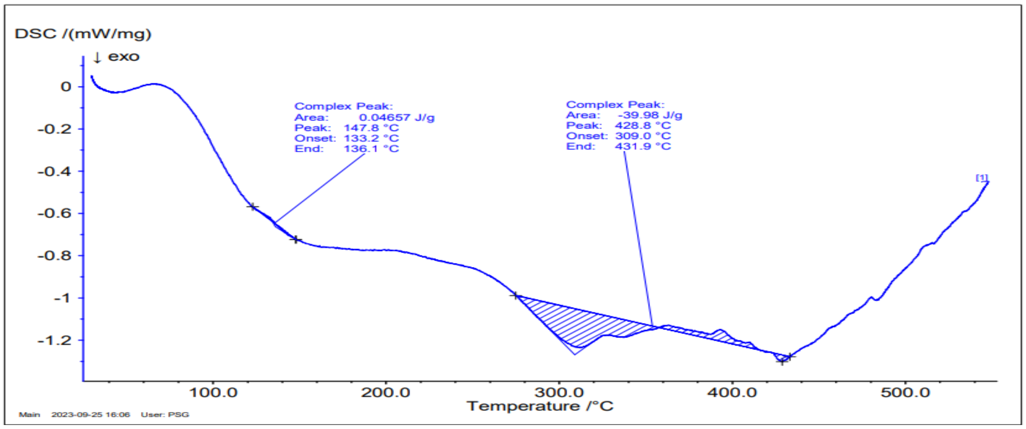
X-Ray Diffraction analysis is utilised to detailing the crystallographic structure, physical property, and chemical composition of the selected sample. XRD was conducted for the samples with SHIMADZU analyser. In this XRD analysis, patterns of fibres are typically a semi-crystalline material, that yields an amorphous broad hump and a crystalline peak. Mangifera indica fibre have a Orthorhombic and Monoclinic structure with the chemical compounds of Neodymium Barium Strontium Copper Oxide (Ba1 Cu3 Nd1 O7.13 Sr1) and Sodium Potassium Copper Tungsten Bromide Oxide (Br1 Cu14 K4 Na19 O193.75 Si4 W36) Difference in the volume of cellulose, hemicellulose, lignin and other particles present in the fibres create rise and down point of peaks in the diagraph.

TGA



Thermogravimetric Analysis (TGA) is applied to examine the thermal stability of selected object or a material and its fraction of unstable components by analysing the weight change that occurs while sample gets heated at a constant rate. TGA analysis for the samples are done with the instrument named NETZCH STA 449 F3. TGA supports the results obtained in the chemical composition analysis decomposition occurs at different levels for hemicellulose, cellulose, and lignin because of its chemical structure. The decomposition of fibre resulted with the reaction of heat of course with four stages. First stage at 30-100 occurs weight loss due to the release of absorbed moisture and water content. Second stage at 100-250 weight loss occurred due to the decomposition of cellulose and third stage at 250-350 results the decomposition of lignin content occurs and at fourth stage 350-600 recorded increase in range of Ash content and it resulted with the residual mass of 30% at 548.1ºC for Mangifera Indica fibre (K.R. Rajisha, 2011).

DSC



Differential scanning calorimetry (DSC) is a method of thermal analysis in which the difference in the rate of heat essential to increase the temperature of a selected sample and the variance is measured as a function of temperature. DSC for the sample is done with NETZCH STA 449 F3 analyser. DSC curves of the fibre as represented shows large exothermic peak at 147.8ºC which characterizes that vaporization occurs to release the absorbed moisture in the surface of fibres. A glass transition is formed at the temperature range of 250º-300˚C. Next exothermic peak at 428.8 ºC Curcuma longa are observed due to the degradation of cellulose. (Ramdhane karoui, 2012)

5. CONCLUSION

These natural based food waste and plant waste from cultivation land are extracted as a raw material to create a greater alternative for already existing textile fibre which requires specific sort of cultivation/ harvesting process that needs several months. It considered as a cost and time-consuming process. But with these natural waste sustainable fibres, cost and time of processing are considerably lower and it doesn't need any specific process of cultivation. By using these sustainable natural waste fibres raw material extraction cost will be comparatively lower than usual natural fibres. Under the category of eco-friendly textiles, these natural waste sustainable fibres will be highly demandable by the consumers in future and will have a greater possible position in textile Market to rule the future. Based on the characterization study of both agro-residual fibres, these are brittle in nature and have a crystalline structure with the better thermal stability that may suitable to serves as a thermal insulation material. Furthermore, properties study and sample test have to be done to get an exact result for the application of thermal insulation material

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GENERATIVE AI AND LIFECYCLE ANALYSIS FOR SUSTAINABLE FASHION DESIGN

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ABSTRACT:

The integration of artificial intelligence (AI) in fashion design is revolutionizing the industry, driving innovation in both creative processes and sustainability practices. Generative AI offers designers advanced tools, such as Generative Adversarial Networks (GANs) and diffusion models, to create unique patterns and textures inspired by diverse inputs, including historical art and natural environments. Simultaneously, AI-powered lifecycle analysis (LCA) enhances the industry's ability to evaluate and minimize the environmental impact of garments from production to disposal.

Generative AI enables designers to push creative boundaries while optimizing fabric usage, reducing waste, and supporting digital prototyping. By combining these creative advancements with AI-driven LCAs, brands can identify eco-friendly materials, optimize production workflows, and design garments for durability and recyclability. This synergy fosters a more innovative, inclusive, and sustainable approach to fashion.

This paper explores the latest developments in generative AI and LCA technologies, showcasing real-world applications in pattern creation and environmental impact analysis. It also addresses challenges such as data availability, intellectual property rights, and the balance between automation and artistry. By leveraging these tools, the fashion industry can embrace a circular economy, ensuring designs are not only visually compelling but also environmentally responsible, shaping a sustainable future for fashion.

Keywords: AI tools, Sustainable, Circular Economy, Designs.

Applications of Generative AI in Fashion

Generative AI is transforming multiple sectors within the fashion industry, offering new avenues for product innovation and consumer engagement. In product development, AI allows designers to input various sketches, fabric options, and color palettes into AI platforms, which can then generate refined, personalized designs. This facilitates more efficient and creative design processes, speeding up development time and enabling experimentation with innovative concepts. Additionally, AI can analyze large volumes of unstructured data, such as social media trends and consumer feedback, to inform design decisions. This allows designers to anticipate trends and create products that resonate with consumer preferences.

Fig: 1- Marketing

For example, AI-assisted eyewear designs use facial topography to tailor frames that fit individuals perfectly. Likewise, AI-supported fashion collections in Hong Kong leverage AI to predict consumer preferences and generate designs aligned with market demand. In marketing and consumer engagement, AI is used to automate content creation and create personalized marketing campaigns. AI tools can generate virtual avatars, craft tailored messages, and automate repetitive tasks, allowing brands to focus on more strategic aspects of consumer interaction. Platforms like TikTok benefit from AI-generated avatars and personalized content, allowing fashion brands to target specific demographics with custom-tailored messages (Fig:1). Tools like Jasper AI and CopyAI help brands optimize campaign development, streamline messaging, and increase resonance with consumers.

Sustainability through Generative AI

Generative AI is proving to be a key player in driving sustainability within the fashion industry. By accurately forecasting demand, AI reduces the overproduction of garments, which is a significant contributor to waste. Additionally, virtual try-on technology powered by AI helps decrease the number of returns, further reducing waste generated from unsold stock. AI platforms such as Stitch Fix use machine learning algorithms to recommend clothing that suits customers' preferences and body types, while Veesual's virtual dressing rooms allow customers to try on clothes digitally before making a purchase. This reduces the number of physical garments produced and discarded.

Generative AI also enables the use of eco-friendly materials and design choices that prioritize sustainability. Companies like Resleeve are leading the charge by utilizing AI models to design digital garments, which eliminates the need for physical prototypes. This approach not only cuts down on fabric waste but also accelerates the design cycle. Through these innovations, AI is integrating sustainability directly into the design and production processes, ensuring that eco-friendly criteria—such as natural fibers, water conservation, and reduced carbon footprints—are embedded in every stage of the design workflow.

Waste Reduction and Resource Efficiency

AI plays an important role in improving resource efficiency and reducing waste in the fashion supply chain. By optimizing waste management processes, AI helps companies more effectively sort, recycle, and repurpose materials. For instance, AI-driven expert systems use data to predict waste generation and recommend strategies for minimizing excess production. Convolutional Neural Networks (CNNs) are used in some cases to classify and sort materials such as textiles, plastics, and glass, improving the recycling process.

Furthermore, AI helps brands align their production with consumer demand, reducing the chances of overproduction, which leads to waste. By analysing historical sales data and consumer preferences, AI systems can predict market demand more accurately and optimize supply chains to ensure that production levels match these forecasts. This reduces surplus inventory and minimizes waste, contributing to a more sustainable, circular economy.

Data-Driven Insights for Sustainable Fashion

The integration of data-driven approaches in fashion through AI provides valuable insights into consumer behavior, market trends, and inventory management. AI algorithms analyze vast amounts of data, such as customer preferences, market dynamics, and sales trends, to make predictions about future demand. By predicting consumer needs, AI helps businesses optimize production schedules and manage inventory more efficiently, reducing overproduction and waste. Predictive analytics are used to forecast demand for particular styles or materials, allowing companies to adjust their production strategies to match market conditions.

Additionally, AI-powered tools help brands optimize their sustainable fashion strategies. By identifying key trends in consumer demand for eco-friendly products, AI can help brands adjust their offerings to meet these needs. Consumer segmentation analysis helps identify specific preferences, making it easier to target diverse markets with sustainable, high-demand products.

Balancing AI and Human Creativity

Although generative AI is revolutionizing the fashion industry, it cannot replace the essential role of human creativity. Fashion design is a deeply personal form of expression, influenced by emotional depth, cultural insight, and intuition—qualities that are uniquely human. These traits are essential for crafting designs that resonate with diverse audiences and reflect social and cultural narratives.

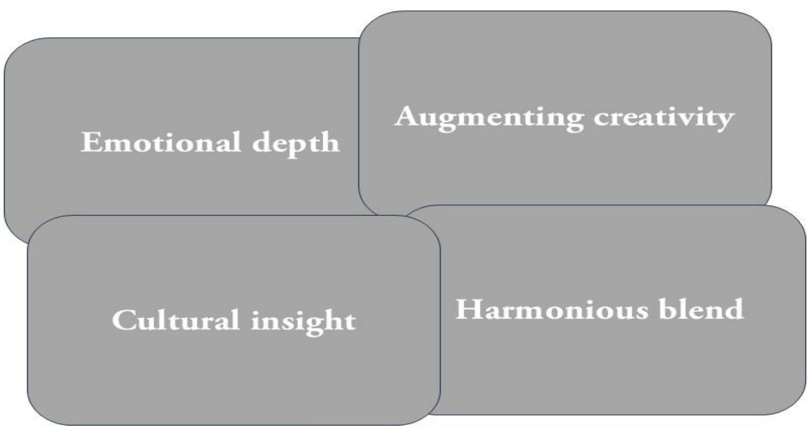

Fig:2- Balancing AI and Human Creativity

Generative AI is best seen as a complementary tool, enhancing and augmenting human creativity. By providing data-driven insights, trend analysis, and efficiency in production, AI enables designers to focus on higher-level creative tasks. AI helps automate repetitive processes, freeing up time for designers to explore new ideas and push boundaries. This synergy of AI and human creativity ensures that fashion remains both innovative and culturally relevant, blending cutting-edge technology with artistic expression (Fig:2).

Implementation Strategies for AI in Fashion

To maximize the potential of generative AI, fashion companies must strategically implement the technology. This involves identifying high-impact use cases, such as creative design, production optimization, or personalized marketing, where AI can provide significant benefits. Developing both short-term roadmaps and long-term goals is crucial to ensure AI integration is executed smoothly and effectively across operations.

Addressing challenges like ethical concerns, legal issues, and intellectual property considerations is vital for successful AI adoption. Companies should implement clear guidelines on how AI is used within the fashion industry to ensure transparency and accountability. Furthermore, training and upskilling employees are essential, with programs such as Levi Strauss's machine learning boot camp helping employees develop the AI skills needed to collaborate with technology.

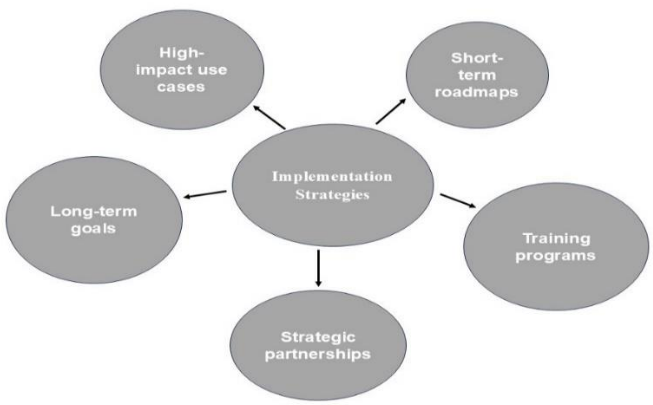

Fig:3 – Implementation Strategies

Strategic partnerships with AI pioneers, like OpenAI or Microsoft, can accelerate AI adoption by giving companies access to the latest technologies and support. These partnerships enable businesses to implement AI-driven solutions quickly and efficiently, without the need to develop complex systems in-house (Fig:3).

AI and Its Revolution in Fashion

AI is revolutionizing fashion product development by providing data-driven insights, predictive analytics, and generative design capabilities. AI technologies gather and analyze vast amounts of data from sources such as social media, e-commerce platforms, and consumer surveys. These insights enable fashion brands to track emerging trends, predict future market demands, and stay ahead of consumer preferences. Through generative design, AI algorithms explore numerous design possibilities, pushing the boundaries of creativity by optimizing products for specific goals like material efficiency or aesthetic appeal.

- **AI (Artificial Intelligence)**
- **Trend Analysis**
- **Generative Design**
- **Predictive Analytics**
- **Fashion Innovation**

Predictive analytics further enhance decision-making by forecasting future demand based on historical data and market dynamics. This allows brands to make informed decisions about inventory, production schedules, and marketing strategies, ensuring that they meet consumer needs while minimizing waste. Tools like Repsketch and Artiphoria use generative AI to create realistic product visuals and digital art, helping designers visualize their ideas before production. These innovations streamline the design and marketing process, helping brands stay competitive and efficient (Fig:4).

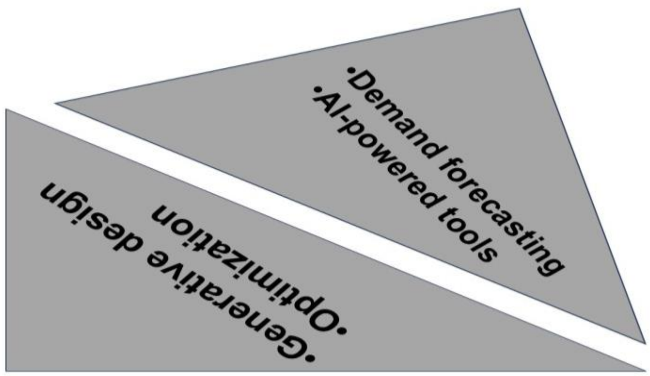

Fig:4 - AI and Its Revolution in Fashion

AI is changing the Sustainability and Circularity in Fashion:

AI is rapidly transforming the fashion industry, driving sustainability and circularity through various innovative technologies and practices. Major developments, such as digital IDs, augmented reality, and machine learning, are revolutionizing how we consume and buy fashion. Generative AI is playing a crucial role in transforming the entire fashion value chain, with significant implications for sustainability and circularity. For instance, AI-powered solutions are helping reduce returns, a major environmental and financial burden on the industry. By improving size and style recommendations through advanced algorithms, AI enables more accurate fitting predictions, ultimately reducing returns and promoting better garment utilization.

AI is also enhancing demand, supply, and product life-cycle management, offering a powerful solution to the issue of overproduction in fast fashion. As AI tools become more accessible, they allow brands to forecast trends and consumer preferences with greater precision, aligning production with actual demand. This shift towards more intelligent and data-driven production systems helps minimize waste and reduce the environmental footprint. Additionally, AI is making supply chains more transparent, addressing the increasing need for traceability and sustainability reporting in the face of regulatory pressure, such as the EU Green Deal and the Digital Product Passport (DPP) initiative. This increased transparency is essential for ensuring that brands meet consumer expectations for ethical practices and sustainable operations.

In the realm of circularity, AI is enabling businesses to adopt circular business models that extend the life of products. With AI supporting digitalized, fully traceable supply chains, brands can track the entire lifecycle of a garment, from its origin to its eventual reuse, repair, or recycling. This shift towards circular practices allows businesses to generate revenue through multiple channels, such as product rentals or repair services, and offers consumers new retail experiences focused on sustainability. By fostering innovation in circularity, AI can help reduce the need for constant production of new garments, thus contributing to a more sustainable and socially responsible fashion industry.

The Future of Fashion with Generative AI

Generative AI represents a transformative force in the fashion industry, offering the potential to enhance sustainability, creativity, and operational efficiency. By combining the computational power of AI with human artistic vision, the fashion industry can achieve unprecedented innovation while maintaining its emotional and cultural relevance. The future of fashion will depend on how well AI is integrated into every step of the supply chain, from design and production to marketing and consumer engagement.

While challenges such as data privacy concerns, bias, and regulatory hurdles remain, the potential of generative AI to revolutionize fashion makes it a crucial tool for forward-thinking brands. By embracing AI, fashion companies can shape the future of the industry by innovating sustainably, improving efficiencies, and delivering products that resonate with evolving consumer demands.

Results and Discussions:

The integration of generative AI in the fashion industry has proven transformative, driving advancements in design, sustainability, consumer engagement, and efficiency. AI has accelerated design processes by enabling designers to create personalized, innovative products, as seen in AI-driven fashion collections and tailored eyewear. By analyzing consumer data, AI enhances marketing campaigns and consumer interactions, offering targeted content and virtual avatars that resonate with specific audiences. Furthermore, AI has contributed significantly to sustainability by reducing waste and optimizing supply chains. Virtual try-ons and AI-driven demand forecasting ensure that production aligns with consumer demand, minimizing overproduction and waste. Companies like Resleeve have pioneered the creation of digital garments, eliminating the need for physical prototypes and conserving resources. AI's ability to predict trends, manage inventory, and enhance waste sorting and recycling has optimized resource utilization, further supporting the transition to a circular economy. However, challenges persist, including the need for large, high-quality datasets to train AI models, and the high cost of implementation, which can be a barrier for smaller companies. Despite these hurdles, AI's potential in driving sustainability is clear, offering fashion companies valuable insights into consumer behavior and market trends. AI’s role in balancing creativity and efficiency has shown that it enhances human creativity rather than replacing it, allowing designers to focus on innovation while AI handles data-driven tasks like trend analysis and material optimization. While data privacy, ethical concerns, and biases remain issues to address, the benefits of AI in fashion are undeniable. Fashion brands that strategically adopt AI technologies can foster innovation, enhance sustainability efforts, and stay ahead of market trends. The future of the fashion industry lies in successfully blending human artistry with AI’s analytical capabilities, creating a more sustainable and innovative fashion landscape.

CONCLUSION

The integration of generative AI into the fashion industry has ushered in an era of unprecedented innovation. Fashion brands leveraging AI technology are positioned to gain a competitive edge through faster design processes, increased customization, and improved resource efficiency. By embracing AI, brands can stay ahead of emerging trends, reduce waste, and create more sustainable products, ultimately setting the foundation for a fashion landscape driven by technology and creativity. The synergy between human ingenuity and AI offers exciting opportunities for the future, enabling fashion brands to lead the way in both sustainability and innovation.

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AI-THE FUTURE FASHION

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ABSTRACT:

The intersection of artificial intelligence (AI) and the fashion industry is becoming increasingly important as technology continues to transform all sectors of life. This paper explores how AI is shaping the future of fashion through innovations in design, manufacturing, retail, and consumer experience. By examining AI applications such as generative design algorithms, predictive analytics, personalized shopping experiences, and sustainable fashion, the study highlights both the opportunities and challenges posed by this technological evolution. It also considers the ethical and societal implications of AI's integration into fashion, including data privacy, job displacement, and the environmental impact. Ultimately, the paper argues that AI holds the potential to revolutionize the fashion industry, making it more efficient, sustainable, and inclusive, while urging stakeholders to thoughtfully navigate its challenges. AI can unlock a future for fashion that is not only innovative but also responsible and inclusive.

Key words: Artificial intelligence, sustainable production, eco-friendly, Ethical concern.

INTRODUCTION:

Fashion has historically been a symbol of creativity and innovation, constantly evolving to reflect the times. Today, artificial intelligence is at the forefront of this evolution, bringing new tools and methodologies that challenge traditional paradigms. From design to consumer interaction, AI is not only enhancing operational efficiencies but also creating new possibilities for personalization and sustainability. However, as with any transformative technology, it brings about both positive and negative implications that must be addressed to ensure its responsible adoption in the fashion industry.

AI in Fashion Design:

One of the most exciting applications of AI in fashion is in the creative process. AI-driven design tools, such as generative algorithms, enable designers to experiment with new styles, patterns, and materials, expanding their creative boundaries. Through machine learning, AI can analyze vast datasets of fashion trends and consumer preferences, allowing designers to create pieces that are more in line with current demands. AI tools also assist in reducing the time spent on repetitive tasks like pattern making or material selection, enabling designers to focus on high-level creative decisions.

Need For AI:

As the trend changes in a moment, fashion industries face many problems in anticipating the people's need and likes. To overcome this, AI is being needed in these industries.[2] The following are the things that AI can help with as mentioned in fig:1

fig:1 Things that AI can help with

AI in Manufacturing and Production:

AI's role in manufacturing is equally transformative. Automation powered by AI enables fashion brands to reduce waste, lower costs, and streamline production timelines. Advanced robotics, augmented with AI, can handle tasks such as cutting fabric or sewing, ensuring high precision while minimizing human error. Moreover, AI-based supply chain management systems optimize inventory by predicting trends, managing stock, and automating reordering processes. This minimizes overproduction, a key issue in the fashion industry, and helps brands embrace more sustainable production methods.

AI in Retail and Consumer Experience:

The retail landscape is also experiencing a profound shift due to AI, particularly through personalized shopping experiences. AI algorithms track customer preferences and behaviors, offering tailored product recommendations. Virtual try-on technologies powered by AI help consumers visualize how clothes will look on them without trying them on physically. AI chatbots and virtual assistants, available 24/7, provide real-time customer support, enhancing user satisfaction. Moreover, AI is playing a role in dynamic pricing, where algorithms adjust product prices based on demand, inventory levels, and competitor pricing.

Sustainability and Ethical Concerns:

Sustainability in fashion has become a major concern, and AI is playing a crucial role in addressing these challenges. AI can help fashion companies develop eco-friendly materials, optimize supply chains, and reduce waste by predicting product demand more accurately. However, the widespread use of AI also raises ethical concerns. The collection and analysis of consumer data raise privacy issues, especially when it comes to biometric data used in virtual try-on applications. Additionally, the automation of jobs in manufacturing could result in job displacement, particularly in developing countries where the fashion industry plays a significant role in employment.

Fashion Brands Embracing AI Technology:

Several fashion brands are leveraging Artificial Intelligence (AI) to enhance their products and services, revolutionizing the customer experience and improving design processes. Notable examples include:

1. **Stitch Fix**: This brand utilizes AI to offer personalized styling services online, suggesting clothing that aligns with individual customer preferences. Additionally, Stitch Fix employs AI to generate new clothing designs and analyze market demand for these products.[4]

2. **Levi's**: Levi's has incorporated an AI technique known as "AI Finish" to enhance denim products. This technique applies specific finishes to jeans, improving their look and feel, and providing a more customized experience for customers.[5]

3. **L'Oréal**: L'Oréal has developed an AI-powered system called **ModiFace** that enables customers to virtually try on makeup and cosmetic products. This technology allows users to see how products will look on their skin in real-time before making a purchase.[6]

4. **Adidas**: Adidas uses AI to design running shoes tailored to individual customer needs. By analyzing customer preferences, the brand creates personalized footwear, optimizing comfort and performance based on the user's specific requirements.

These fashion brands demonstrate how AI is becoming an integral part of the industry, enhancing customer experience, improving product design, and meeting personalized demands.

Advantages of AI used in fashion industry:

Some of the advantages of AI that is being used in fashion industry are:

- Meets demand production
- Inventory management
- Creates new designs and ideas
- High efficiency
- Improves product quality
- Enhances customer experiences
- Improved sustainability.

Disadvantages of using AI in fashion industry:

Some of the disadvantages of AI that is being used in fashion industry are:

- High investment
- Rapid update in technology
- Lack of AI skills
- Less data privacy
- Consumer distrust

Survey conducted regarding AI:

A survey is conducted regarding AI uses in fashion industry. The questionnaire includes the questions such as

1. Do you think AI is better than human services? (fig:10)
2. Does AI reduce human's work, time and energy? (fig:11)
3. Which work you prefer to make easier using AI? (fig:12)
4. Do you think AI replaces the employees and avoids human errors? (fig:13)
5. Do you think AI used in smart textiles helps people? (fig:13)

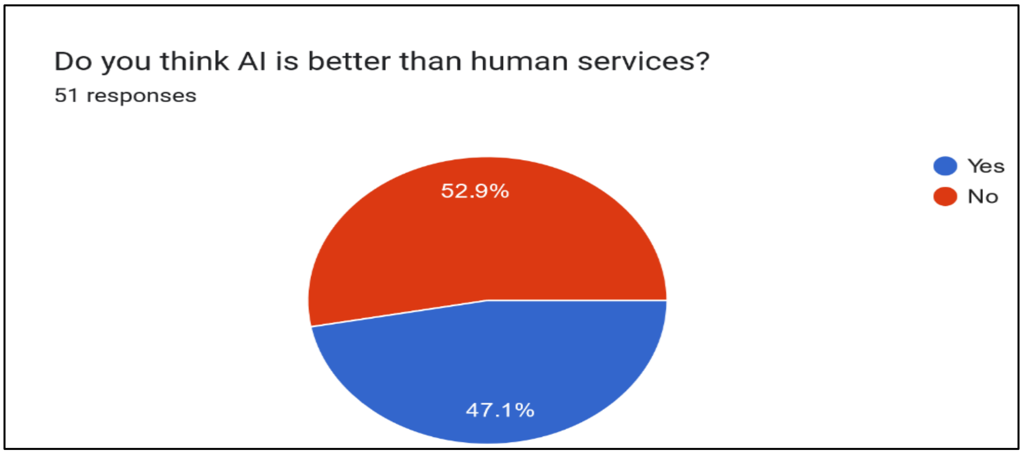

Fig:2 People who think AI is better than human services

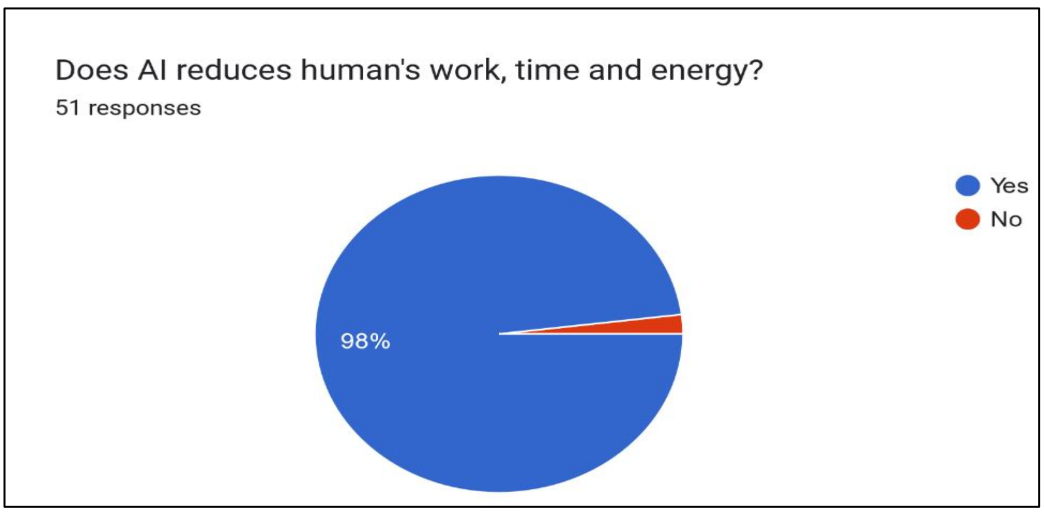

Fig:3 People who think AI reduces human work, time & energy

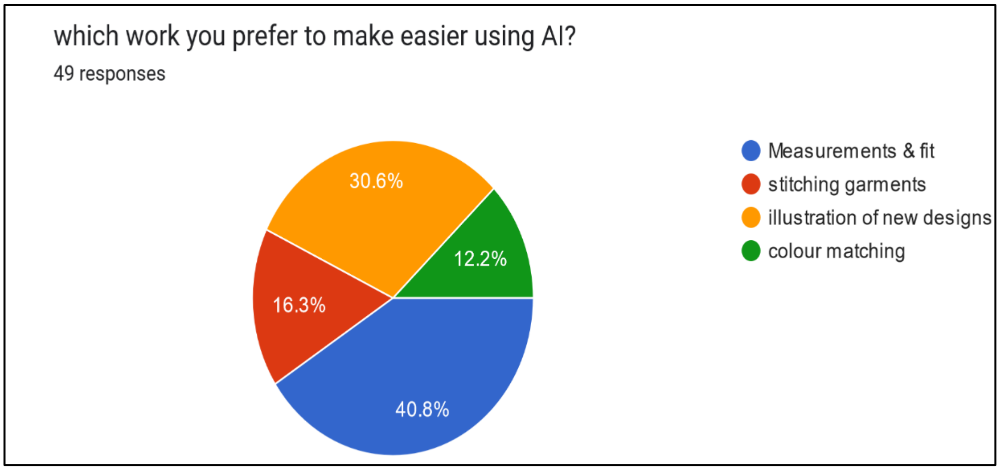

Fig:4 Work preferred by people done by AI

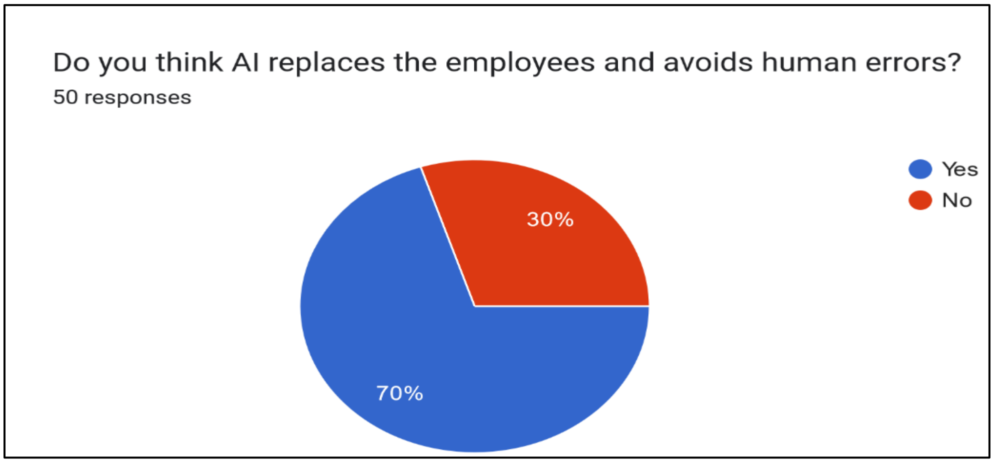

Fig:5 AI replaces employees and avoids human errors

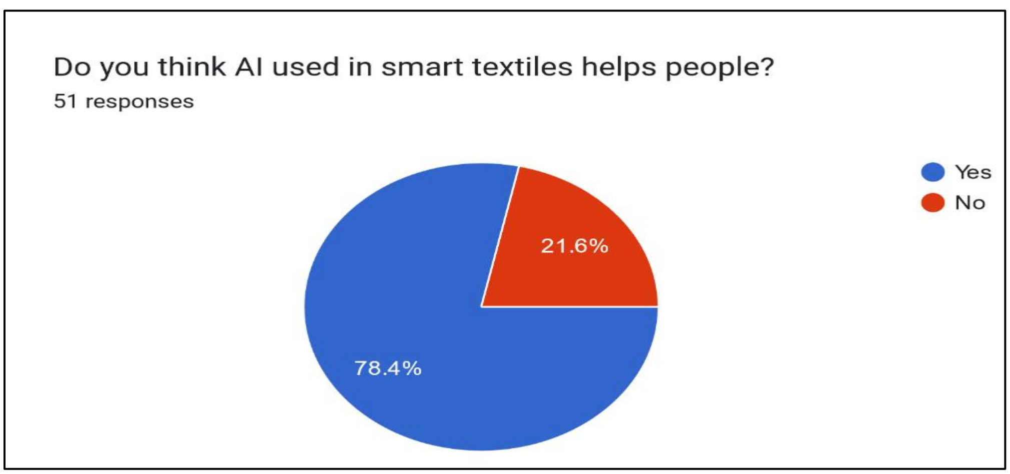

Fig:6 AI's help in smart textiles

Majority of the people have responded positively towards the survey and many find it that AI is useful. In India, AI's usage in fashion industry is still in the stage of set about. Mumbai city has the usages of AI in fashion industry than any other state. AI may bring a vast transformation in fashion industry. Hence AI must be promoted to be used in all the fashion industry.

CONCLUSION:

AI is undeniably a catalyst for change in the fashion industry, offering groundbreaking opportunities to enhance creativity, efficiency, and sustainability. However, as fashion companies continue to adopt AI technologies, they must remain mindful of the broader societal implications, from ethical data usage to the potential environmental footprint of large-scale AI adoption. By addressing these concerns proactively, AI can unlock a future for fashion that is not only innovative but also responsible and inclusive.

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AI IN FASHION TREND FORECASTING: APPLICATIONS, CHALLENGES, AND FUTURE DIRECTIONS

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ABSTRACT

The fashion industry has long faced the challenge of accurately predicting future trends, a task complicated by rapidly changing consumer preferences, seasonal shifts, and cultural influences. In recent years, artificial intelligence (AI) has emerged as a powerful tool to enhance fashion trend forecasting. By analysing vast amounts of data and recognizing patterns, AI can offer insights that traditional methods cannot match. This paper delves into the various applications of AI in fashion trend forecasting, including its ability to process big data, predict trends in real time, and analyse consumer behaviour. Additionally, the paper explores the challenges and limitations of integrating AI into fashion and considers the future of AI-driven trend forecasting in the fashion industry.

Keywords; AI, Big data, Forecasting, Predicting.

1. Introduction

The global fashion industry is a fast-moving sector, with trends evolving rapidly due to cultural shifts, social media influence, economic changes, and technological advancements. Traditionally, fashion trend forecasting was based on expert predictions, historical data analysis, and seasonal pattern recognition. However, these methods often proved slow, reactive, and error-prone.

In recent years, artificial intelligence (AI) has been leveraged to transform how fashion trend forecasting is conducted. AI's ability to analyse vast datasets from various sources—such as social media platforms, online retail data, and fashion shows—allows it to identify emerging trends faster and more accurately than traditional methods. AI-driven tools can also predict shifts in consumer behaviour, track real-time changes in market demand, and suggest products that align with future preferences.This paper aims to explore the various applications of AI in fashion trend forecasting, discuss the benefits and challenges of implementing AI in the industry, and outline potential future directions for AI-powered forecasting.

2. AI Applications in Fashion Trend Forecasting

AI technologies, such as machine learning (ML), deep learning (DL), and computer vision, are transforming how fashion trends are predicted. Below are the key areas where AI is being applied in fashion trend forecasting in figure 1.

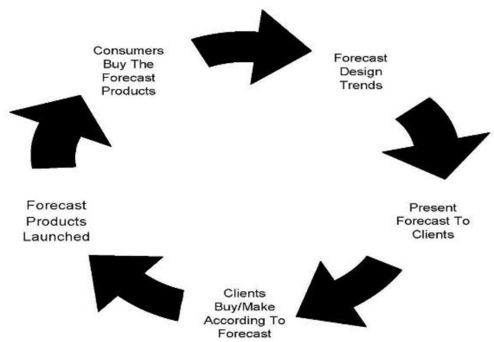

Fig .1 AI powered Trend Forecasting

2.1. Data-Driven Trend Analysis

AI is particularly adept at processing and analysing large volumes of data. By gathering information from various sources like social media, fashion blogs, e-commerce platforms, and online forums, AI systems can recognize patterns in consumer behaviour and forecast upcoming trends.Table 1 below illustrates various data sources used in AI-based fashion trend forecasting:

Table 1.Various data sources used in AI-based fashion trend forecasting:

Data Source	**Type of Data**	**Purpose**
Social Media	Tweets, Instagram posts, TikTok videos	Identify emerging colors, styles, and influencers
Fashion Shows	Runway images, designer collections	Predict seasonal trends, fabric preferences
E-commerce Platforms	Sales data, product reviews	Gauge consumer preferences, popular products
Consumer Sentiment Data	Online surveys, product feedback	Understand shifts in consumer attitudes

These sources provide valuable insights into the next wave of fashion trends, enabling more accurate predictions than conventional forecasting methods.

2.2. Real-Time Trend Prediction

AI excels at real-time data analysis, which allows fashion brands to quickly identify shifts in consumer behavior and adjust their strategies accordingly. For example, tools like Edited, Trendalytics, and Heuritech continuously monitor social media platforms, influencer activity, and online sales data to identify emerging styles, colors, and fabrics.

The ability to predict trends in real time allows brands to:

- Reduce lead times for production and distribution
- Respond rapidly to consumer demand

- Align product offerings with emerging trends, minimizing the risk of overproduction

below shows an example of how real-time trend forecasting works, highlighting the process from data collection to prediction.

Real-Time Trend Prediction Process

1. Data Collection: AI collects data from various platforms (social media, retail, blogs).
2. Data Processing: AI algorithms analyze this data to identify emerging trends.
3. Trend Prediction: AI systems generate predictions on future trends and recommend actions for brands.

2.3. Consumer Behaviour and Sentiment Analysis

AI-driven sentiment analysis tools can examine consumer opinions and feedback to gauge the popularity of specific styles, brands, or fashion products. By processing vast amounts of textual data from online reviews, social media posts, and fashion forums, AI can detect underlying sentiment (positive, neutral, negative) and predict how these sentiments might influence future trends.

For instance, brands can use sentiment analysis to identify which styles resonate most with specific demographic groups. By combining sentiment analysis with demographic data, AI can help fashion companies:Table. 2 below demonstrates the AI-driven sentiment analysis process.

- Create personalized marketing campaigns
- Improve product offerings
- Align designs with consumer sentiment and preferences

Table 2. Sentiment Analysis for Fashion Trend Forecasting

Types of Analysis	Description
1. Text Data Collection	Collect text data from social media, online forums, and reviews
2. Text Preprocessing	Clean and preprocess the data for sentiment analysis
3.Sentiment Classification	Classify text as positive, neutral, or negative
4. Trend Forecasting	Generate predictions about future trends based on sentiment

2.4. Visual Recognition and Image Processing

Computer vision, a subfield of AI, allows for the analysis of visual data such as images and videos. In the fashion industry, computer vision is used to recognize patterns in fashion imagery, runway photos, and street style images. These visual inputs are processed by deep learning algorithms, which can identify trends in color, fabric, shape, and silhouette. Fig.2 below demonstratesAI Powered Trend Forecasting; How to Predict the future of your.

Fashion brands can use AI-powered image recognition tools to:

- Detect new fashion styles and design elements
- Identify emerging color palettes or fabric patterns
- Track how certain styles evolve across fashion seasons

Fig 2. AI Powered Trend Forecasting; How to Predict the future of your.

For example, AI tools like Heuritech use image recognition to analyse runway collections and street style photos to forecast upcoming fashion trends. Table 3 illustrates how AI-powered visual recognition works in fashion trend forecasting.

Table 3. Visual Recognition in Fashion Trend Forecasting

Techniques	**Description**
1. Image Collection	Collect images from fashion shows, social media, street style
2. Image Processing	Use computer vision algorithms to detect patterns
3. Trend Analysis	Identify common patterns (colors, styles, silhouettes)
4. Forecasting	Predict the popularity of specific trends

3. Benefits of AI in Fashion Trend Forecasting

The integration of AI into fashion trend forecasting offers several key advantages:

3.1. Enhanced Accuracy and Efficiency

AI's ability to process large volumes of data quickly and identify patterns that are invisible to humans leads to more accurate and reliable predictions. Unlike traditional forecasting methods, which rely on intuition and subjective judgment, AI-powered systems base their predictions on objective data analysis.

3.2. Speed and Agility

AI's real-time analysis allows fashion companies to respond faster to market shifts. In industries like fast fashion, where lead times can make or break a brand, AI provides a competitive advantage by enabling quicker production cycles and faster product launches.

3.3. Personalization

By analysing consumer behaviour, AI can offer personalized recommendations to individual customers. This personalization not only enhances the shopping experience but also helps brands create targeted marketing campaigns and improve customer loyalty.

3.4. Cost Savings

Automating the trend forecasting process reduces the need for manual research and expert consultations, leading to significant cost savings for fashion brands. Moreover, accurate predictions reduce the risk of overproduction and unsold inventory.

4. Challenges and Limitations

Despite its advantages, the use of AI in fashion trend forecasting comes with several challenges:

4.1. Data Quality and Bias

AI is only as good as the data it is trained on. Poor-quality, incomplete, or biased data can lead to inaccurate predictions. In fashion, where trends are often influenced by intangible factors like culture and personal taste, creating unbiased, representative datasets can be particularly challenging.

4.2. Privacy Concerns

AI-driven fashion trend forecasting often relies on data collected from consumers, including their online behaviours and purchasing history. This raises privacy concerns, particularly in light of regulations like the General Data Protection Regulation (GDPR) in the European Union. Fashion companies must ensure they handle consumer data responsibly and comply with relevant laws.

4.3. Lack of Interpretability

AI models, particularly deep learning algorithms, are often seen as "black boxes" because their decision-making processes are not always transparent. This lack of interpretability can be a barrier to adoption, as fashion companies may hesitate to rely on systems that they cannot fully understand or explain.

5. Future Directions

As AI technology continues to evolve, several exciting opportunities emerge for the future of fashion trend forecasting

5.1. Advanced Predictive Models

The future of AI in fashion forecasting lies in developing more sophisticated predictive models that combine machine learning with other AI techniques such as natural language processing (NLP) and reinforcement learning. These models could offer even more accurate, granular predictions of future trends.

5.2. Sustainable Fashion Forecasting

AI could be used to identify and predict trends in sustainable fashion, helping brands meet the growing consumer demand for eco-friendly products. By analyzing data on sustainable materials, ethical production practices, and consumer sentiment toward environmental issues, AI could play a key role in promoting sustainable fashion trends.

5.3. Integration with Virtual Fashion

With the rise of virtual fashion, including digital fashion shows, augmented reality (AR), and the metaverse, AI could be used to predict trends in these emerging digital spaces. This would allow fashion companies to explore new opportunities in virtual retail and digital fashion design.

6. Conclusion

AIis transforming the fashion industry by enabling more accurate, efficient, and personalized trend forecasting. Its ability to analyse vast amounts of data in real-time, predict consumer behavior, and recognize emerging styles through visual recognition is revolutionizing how fashion brands approach design, production, and marketing. While challenges such as data quality, privacy concerns, and model interpretability remain, the future of AI in fashion trend forecasting looks promising, with the potential to reshape the industry in innovative ways.

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INNOVATION AT THE INTERSECTION OF TEXTILES AND TECHNOLOGY

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ABSTRACT:

Smart fabrics, or e-textiles, represent a groundbreaking convergence of textiles and advanced technology, enabling fabrics to sense, monitor, and respond to environmental or physiological changes. These fabrics, categorized into passive, active, and ultra-smart types, are revolutionizing industries such as healthcare, sports, military, and fashion by integrating functionalities like energy harvesting, biometric monitoring, and real-time interactivity.

Recent technological advancements, including piezoelectric and photovoltaic energy harvesting, nanotechnology-enhanced durability, and graphene-based conductivity, have expanded the potential of smart fabrics. Biometric monitoring systems woven seamlessly into textiles are transforming healthcare and sportswear by providing real-time health data and performance insights. Meanwhile, self-healing materials and biodegradable fabrics are driving sustainability efforts, addressing environmental concerns and enhancing durability.

Despite their transformative potential, smart fabrics face challenges such as washability, production scalability, high material costs, and privacy concerns regarding biometric data. However, ongoing developments, such as artificial intelligence integration and flexible battery technologies, promise a future where smart fabrics become more adaptive, sustainable, and widely accessible.

Key words: Passive smart fabrics, Active smart fabrics, Ultra-smart fabrics,Biometric Monitoring.

1. INTRODUCTION

Smart fabrics, also known as e-textiles or electronic textiles, represent an innovative intersection between textiles and advanced technology, blending traditional fabric properties with new functionalities that respond to environmental stimuli. These fabrics are engineered to sense, monitor, and sometimes even react to changes in the surroundings or the wearer's body, positioning them at the forefront of wearable technology. The rapidly growing interest in smart fabrics is fuelled by the increasing demand in sectors such as healthcare, sports, military, and consumer fashion, where adaptability and interactivity are paramount. As technology advances, the capability of smart fabrics to incorporate sensors, conductive fibers, and microprocessors has expanded dramatically, enabling them to perform complex tasks that were once confined to electronic devices.

2.TYPES OF SMART FABRICS

Smart fabrics can be categorized into three primary types based on their capabilities and level of interactivity:

2.1 Passive smart fabrics.
2.2 Active smart fabrics.
2.3 Ultra-smart fabrics.

2.1 Passive smart fabrics.

Passive smart fabrics have the simplest structure and can sense environmental changes without reacting examples include UV-protective clothing or moisture-wicking fabrics.

2.2 Active smart fabrics.

Active smart fabrics represent a significant evolution in textile technology, characterized by their ability to sense environmental changes and respond dynamically. These fabrics incorporate electronic components, such as sensors and actuators, enabling them to perform functions that go beyond traditional textiles.

2.3 Ultra-smart fabrics.

Ultra-smart fabrics can change their behavior without prior tuning or manual intervention. They are designed to adapt dynamically to various stimuli such as temperature, pressure, and light. Equipped with microchips that act like a brain, these textiles can process information, reason, and activate responses based on environmental inputs.

3. RECENT TECHNOLOGICAL ADVANCEMENTS

3.1 Energy Harvesting Fabrics

One of the most significant advancements in smart fabrics is the integration of energy-harvesting capabilities, enabling these materials to generate power from the wearer's movements or environmental sources. Innovations in piezoelectric fibers have enabled fabrics to convert mechanical stress, such as bending or stretching, into electrical energy. These developments are particularly promising for wearable devices that require power, as energy-harvesting fabrics could potentially eliminate the need for batteries, making the devices lighter and more sustainable. Another advancement is the embedding of photovoltaic cells directly into the fabric, allowing it to harness solar energy. This application is not only innovative but also environmentally friendly, as it reduces dependency on external power sources.

3.2 Nanotechnology in Fabrics

The utilization of nanotechnology in smart fabrics has led to revolutionary improvements in durability, flexibility, and functionality. By applying nano-coatings to textiles, researchers have created fabrics with enhanced properties, such as waterproofing, stain resistance, and even self-cleaning capabilities. Graphene, a highly conductive and flexible material, has also been incorporated into textiles to improve electrical conductivity without sacrificing comfort. This has led to the development of graphene-based fabrics that can transmit signals and monitor physiological changes in the body. Graphene's lightweight and resilient nature make it ideal for applications requiring both durability and comfort, especially in sportswear and medical devices.

3.3 Biometric Monitoring

Biometric monitoring in smart fabrics is a field that has seen remarkable growth, especially within the healthcare and sports industries. By embedding sensors that can track physiological signals such as heart rate, body temperature, and muscle activity, smart fabrics enable real-time health monitoring without the need for external devices. Advances in fiber optic technology and conductive polymers have allowed these sensors to be seamlessly woven into the fabric, creating a comfortable and unobtrusive experience for the user. Wearable garments equipped with biometric sensors are now used in high-performance sportswear to optimize training and recovery, as well as in patient monitoring systems in healthcare settings to provide continuous, non-invasive tracking.

4. PROMINENT APPLICATIONS OF ADVANCED SMART FABRICS

4.1 Healthcare and Rehabilitation

In healthcare, smart fabrics have transformative potential, especially in patient monitoring and rehabilitation. Wearable garments with integrated sensors can continuously monitor vital signs such as heart rate, respiration, and even blood pressure, making it easier for healthcare professionals to track patients' health. Some smart fabrics are designed for rehabilitation purposes, where they provide feedback on posture and movement to help patients recover from injuries. This type of biofeedback can be essential for those undergoing physical therapy, as it allows for more precise control and monitoring of muscle activity, thereby enhancing the effectiveness of rehabilitation exercises.

4.2 Sports and Fitness

For athletes and fitness enthusiasts, smart fabrics offer a range of benefits, from performance tracking to injury prevention. Advanced fabrics in sportswear often incorporate motion sensors and temperature-regulating fibers that can analyze the wearer's movements and adapt to maintain optimal body temperature. High-tech sportswear using such fabrics has become invaluable for training optimization, as it can provide data on endurance, muscle fatigue, and calorie expenditure. These fabrics are also designed with moisture-wicking and antimicrobial properties to enhance comfort during prolonged use. By integrating real-time feedback capabilities, these smart garments allow athletes to make data-driven adjustments to their training routines.

4.3 Military and Defense

The military and defense sector is one of the earliest adopters of smart fabrics, largely due to the benefits these fabrics offer in harsh and high-stakes environments. Military uniforms now incorporate temperature-regulating and protective materials that can shield soldiers from extreme weather conditions or even minor chemical exposures. One of the most advanced applications is health-monitoring uniforms, which can detect stress levels, fatigue, and other physical indicators to ensure that soldiers are performing at their best. Energy-generating fabrics are also being explored to power small devices, making them ideal for soldiers in remote locations where traditional power sources are scarce.

4.4 Fashion and Everyday Wear

The fashion industry is leveraging smart fabrics to create adaptable, interactive, and personalized clothing. High-tech garments can now change color, emit light, or even alter their texture, offering a new realm of possibilities for self-expression. Moreover, some smart fabrics are designed with temperature-regulating or moisture-control properties, enhancing everyday comfort. Sustainable smart fabrics, which focus on eco-friendly materials and energy-efficient designs, are also emerging as a key trend in the fashion world. These garments demonstrate that technology-enhanced clothing can be both functional and stylish, appealing to environmentally-conscious consumers.

5. MATERIAL INNOVATIONS IN SMART FABRICS

5.1 Conductive Polymers and Graphene-Based Materials

Recent advancements in conductive polymers and graphene-based materials have enabled new possibilities in smart fabrics. Conductive polymers offer flexibility, durability, and high conductivity, making them suitable for integration into wearable technology. Graphene, known for its remarkable strength and conductivity, is increasingly used in fabrics that require lightweight properties without compromising on electrical performance. These materials are especially valuable in applications requiring data transmission or sensor integration, such as in fitness wearables and patient-monitoring clothing.

5.2 Self-Healing Materials

Self-healing materials represent an innovative leap in fabric technology, significantly extending the lifespan of smart garments. Using polymers that can autonomously repair minor damage, these fabrics can maintain their functionality even after sustaining cuts or abrasions. This advancement is particularly advantageous for applications where durability is essential, such as in military and industrial settings. By enabling fabrics to self-repair, manufacturers can reduce waste and increase the sustainability of smart fabrics, contributing to a more eco-friendly industry overall.

5.3 Biodegradable and Eco-Friendly Smart Fabrics

As sustainability becomes a global priority, the development of biodegradable and eco-friendly smart fabrics is gaining momentum. These fabrics are designed to decompose naturally at the end of their life cycle, addressing the environmental impact of textile waste. Researchers are also exploring organic materials that can conduct electricity, such as cotton or wool infused with biodegradable conductive inks. By using eco-friendly components, these fabrics provide an alternative to traditional textiles that often rely on synthetic materials and energy-intensive manufacturing processes.

5.4 Challenges in Smart Fabrics

Despite the impressive advancements, smart fabrics face several challenges that hinder their widespread adoption. Durability and washability remain major concerns, as many smart fabrics degrade when exposed to repeated washing or environmental stress. Additionally, balancing comfort with functionality is a challenge, as integrating sensors and conductive fibers can sometimes compromise the fabric’s flexibility and feel. The scalability of production and the high cost of materials further complicate the commercial viability of smart fabrics. Privacy concerns related to biometric data collection are another barrier, particularly as more personal data is being tracked and transmitted.

5.5 Future Outlook and Potential Developments

The future of smart fabrics is marked by exciting potential developments, including the integration of artificial intelligence for personalized user experiences. With AI, smart fabrics could adapt in real-time to the wearer's needs, such as adjusting temperature or offering health insights based on biometric data. Flexible battery technologies are also advancing, promising longer-lasting power for smart garments without bulky battery packs. The increasing focus on sustainability is likely to drive further innovation in biodegradable and recyclable fabrics, aligning with the global push for greener technologies. Another intriguing possibility is the development of fabrics with enhanced interactivity, such as user-controlled lighting effects or customizable patterns that respond to voice commands.

6. CONCLUSION

The latest advancements in smart fabrics highlight an ongoing evolution in textiles, where traditional garments are becoming high-tech, multifunctional, and responsive. As these fabrics continue to develop, they promise transformative impacts across industries, from healthcare to fashion, by improving comfort, functionality, and interactivity. The future of smart fabrics is bright, with new innovations on the horizon that will continue to shape how we interact with our clothing and environment. The intersection of textiles and technology is creating a new paradigm of "wearable intelligence," paving the way for a future where our clothing is not only an expression of style but also a tool for enhancing our daily lives.

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SUSTAINABLE DYEING PRACTICES - A PATH TOWARDS A GREENER TEXTILE INDUSTRY

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ABSTRACT

The textile industry, a cornerstone of global economic growth, is notorious for its environmental impact, particularly due to traditional dyeing methods that consume excessive water, release toxic chemicals, and generate hazardous waste. In response to increasing environmental awareness and regulatory pressures, the industry is adopting sustainable dyeing practices to mitigate ecological harm. This article explores the concept of sustainable dyeing, emphasizing its techniques, benefits, and challenges.

Sustainable dyeing minimizes environmental damage by conserving resources, reducing waste, and eliminating harmful chemicals through methods such as bio-dyeing, waterless dyeing technologies, and the use of natural dyes. Advanced innovations, including hybrid pigments, microbial pigments, plasma technology, and ultrasound-assisted dyeing, are redefining the dyeing process with enhanced efficiency and reduced ecological footprints. Key techniques like CO_2-based dyeing, enzymatic dyeing, and cationization exemplify the industry's commitment to eco-friendly solutions.

These practices not only preserve the environment but also offer economic benefits, align with consumer preferences, and enhance brand reputation. Sustainable dyeing holds transformative potential to reduce the textile sector's environmental impact and drive long-term sustainability through innovation, collaboration, and supportive policies.

Key words: CO2 Dyeing, Dye-Polymer Hydrides, Nanocomposite Hybrids, ColorZen.

1.INTRODUCTION

The textile industry is renowned for its significant contribution to global economic growth but is equally infamous for its environmental footprint. Traditional dyeing methods often involve toxic chemicals, excessive water usage, and the generation of hazardous waste, leading to severe ecological consequences. As environmental awareness and regulatory pressures increase, the industry is transitioning toward sustainable dyeing practices to reduce its ecological impact. This article delves into the innovative methods in sustainable dyeing, their benefits, challenges, and the role they play in promoting an environmentally friendly textile sector.

2.UNDERSTANDING SUSTAINABLE DYEING

Sustainable dyeing encompasses techniques that minimize environmental damage throughout the dyeing process. These methods aim to conserve resources, reduce waste, and eliminate harmful chemicals. Traditional dyeing processes typically utilize synthetic dyes and large volumes of water, resulting in significant pollution and resource depletion. In contrast, sustainable practices focus on mitigating these impacts through innovative approaches, such as the use of natural dyes, waterless dyeing technologies, and bio-based processes.

3.THE ENVIRONMENTAL IMPACT OF CONVENTIONAL DYEING

3.1. Excessive Water Usage

Conventional dyeing methods consume large volumes of water—up to 200 liters per kilogram of fabric. This not only depletes freshwater resources but also generates contaminated wastewater containing toxic dyes and chemicals that harm aquatic ecosystems and groundwater supplies.

3.2. High Energy Consumption

High-temperature dye fixation processes demand considerable energy, contributing to greenhouse gas emissions. The energy-intensive nature of these methods exacerbates the industry's carbon footprint.

3.3. Chemical Pollution

Synthetic dyes and auxiliaries often contain hazardous substances, including heavy metals, which pose risks to human health and the environment. The improper disposal of dyeing effluents leads to severe ecological imbalances.

4. SUSTAINABLE DYEING TECHNIQUES

4.1. Bio Dyeing

Bio Dyeing employs biological processes to produce and apply dyes. This method harnesses the natural capabilities of microorganisms to create vibrant colours sustainably. Two primary techniques within Bio Dyeing include:

- **Fermentation Dyeing:** This technique uses microbial fermentation to develop dyes from organic materials.
- **Enzymatic Dyeing:** Enzymes are utilized to fix dyes onto fabrics more efficiently, reducing the need for harsh chemicals.

4.2. Waterless Dyeing Techniques

4.2.1.CO2 based Dyeing

Developed by companies like DyeCoo, this innovative method uses pressurized carbon dioxide instead of water to carry and deliver dyes to fabrics. The process significantly reduces water usage and eliminates wastewater production. After dyeing, most CO_2 can be recovered and reused, making it an efficient and sustainable option.

4.2.2. Air Dyeing

Air dyeing technology employs a jet of air to inject dyes directly into fabrics in gas form. This method drastically reduces water consumption and chemical usage compared to traditional techniques.

4.3. Natural Dyes

Natural dyes are derived from plants, minerals, or insects and have been used for centuries. They are biodegradable and generally less harmful than synthetic dyes. However, the availability of raw materials and variability in color consistency can be challenges in their widespread adoption.

4.4. Salt-Free Dyeing

Traditional dyeing processes often require large amounts of salt as an electrolyte, which contributes to wastewater pollution. Salt-free dyeing techniques involve pre-treating fabrics with cationic polymers that enhance dye affinity without the need for salts. This approach reduces both chemical usage and environmental impact.

5. INNOVATIONS IN SUSTAINABLE DYEING

5.1. **Hybrid Pigments**

A novel class of colourants known as hybrid pigments blends inorganic and organic ingredients in an effort to maximise the benefits of each type for improved performance in a range of applications, most notably in textiles and cosmetics. Better colour fastness, adaptability, and environmental sustainability are made possible by this special formulation. Several kinds of hybrid pigments are as follows:

5.1.1 Dye-Polymer Hydrides: These improve wash-off procedures and enable low-temperature dyeing by chemically binding dye molecules to polymer particles.

5.1.2 Nanocomposite Hybrids: By adding nanoparticles, such metal oxides or clays, these hybrids improve their thermal stability and antibacterial capabilities.

5.1.3 Organic-Inorganic Hybrids: These pigments create remarkable colour depth and stability by combining organic and inorganic chemicals through covalent bonding.

5.2. Water less Dyeing Techniques:

5.2.1. Dye Coo Technology:

This technique dyes fabrics without the need of water by using supercritical carbon dioxide (CO_2). By being pressurised and transformed into a supercritical condition, the CO_2 effectively dissolves dyes. This method greatly reduces waste by removing the need for extra chemicals and boasting a 98% dye absorption rate.

5.2.2 Air Dye Technology:

Created by a Japanese business, Air Dye transfers colours onto textiles using air rather than water. Compared to conventional approaches, this procedure significantly reduces the amount of water (by 90%) and energy (by 85%) used.

5.3. Innovative Pretreatment Methods

5.3.1. ColorZen:

Compared to conventional procedures, this unique technique pre-treats cotton to improve colour absorption while using 90% less water, 75% less energy, and 90% less chemicals. In order to improve dye bonding, it uses a quaternary ammonium chemical to give cotton fibres a positive charge.

5.3.2. Cationization:

By altering cotton fibres, this technique improves dye exhaustion and uses less dye overall by doing away with the requirement for salts during the dyeing process. By changing the molecular structure of the fibre, methods such as ECOFAST pure and Colorizer technology enhance the absorption of colours.

5.4. Microbial Pigment Techniques

Using bacteria to create natural textile dyes, microbial pigment processes provide a sustainable substitute for conventional synthetic dyes. Different bacterial strains create microbial pigments, which may be harvested and used to colour textiles like silk and cotton. Usually, the procedure entails growing the bacteria in nutrient-rich environment, where they generate colours that can be extracted and used on textiles.

5.4.1. Colorifix:

This novel method creates natural colours without the need of commercial chemicals by using fermented microorganisms. The technique makes use of organisms that have been biologically modified to naturally contain the salts required for dye infusion.

5.2. Ultrasound and Microwave Technologies

These technologies enhance dye penetration into fabrics while reducing water consumption and processing time. Ultrasound waves can facilitate better dispersion of dyes in solutions, while microwave energy can accelerate the dye fixation process.

5.3. Plasma Technology

Plasma technology modifies fabric surfaces at a molecular level to improve dye adhesion without the need for additional chemicals or water. This method is still under research but shows promise in enhancing sustainability in textile processing.

6.BENEFITS OF SUSTAINABLE DYEING

6.1. Environmental Preservation

Sustainable practices significantly reduce the consumption of water and energy, mitigating the textile industry's environmental footprint. They also prevent chemical pollutants from entering ecosystems.

6.2. Economic Advantages

Eco-friendly dyeing methods offer long-term cost savings by conserving resources. They also enhance brand reputation and align with consumer preferences for sustainability.

6.3. Consumer Appeal

With increasing awareness of sustainability, consumers are actively seeking ethically produced textiles. Sustainable dyeing practices help brands meet this demand and build customer loyalty.

7. CHALLENGES IN IMPLEMENTING SUSTAINABLE PRACTICES.

Despite the advancements in sustainable dyeing techniques, several challenges remain:

- **Cost Implications:** The initial investment for advanced equipment can be high, particularly for small to medium enterprises (SMEs) in the textile sector.
- **Technical Limitations:** Not all sustainable methods are suitable for every type of fabric or dye; ongoing research is essential to tailor solutions effectively.
- **Market Acceptance:** There is a need for greater consumer awareness regarding the benefits of sustainable textiles to drive demand for eco-friendly products.

8. CONCLUSION

Sustainable dyeing practices are transforming the textile industry by reducing its environmental impact while meeting consumer demand for ethical and eco-friendly products. Although challenges such as high costs and scalability persist, advancements in technology, policy support, and industry collaboration can accelerate their adoption. By embracing sustainable dyeing, the textile sector can take a vital step towards environmental responsibility and long-term viability.

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COMPARATIVE STUDY ON ENHANCING THE ENVIRONMENTAL AND ECONOMIC VIABILITY OF COTTON BLEND FABRIC USING NATURAL DYES

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ABSTRACT

The objective of this work was to assess the possibility of dyeing a substrate composed using natural dyes from common madder (Rubia Tinctorum L.) and calendula (Calendula Officials) and tannin and alum as mordants. The substrate used for the dyeing had a 25/75 cotton composition. The hemp raw material is an agricultural by-product that was subjected to mechanical and chemical treatments in order to cottonize the fibers, blend them with cotton, and thus obtain first 40-tex open-end yarns and then a knitted fabric. The latter was subjected to different dyeing conditions by varying the dye, mordant, and method for its application, type of water, and rinsing after dyeing. The results showed that dyeing of a non-textile residual hemp substrate is possible, and that calendula is a good option for dyeing it with tap water, tannin-alum set in a meta-mordanting process, and rinsing after 24 h. In this way, a contribution has been made to the circular economy of the textile industry through the use of more sustainable sources and products. Conventional methods for application of vegetable dyes have been lost due to hundreds years of neglect. In this work, vegetable dyes have been applied on cotton by various methods viz., open bath, multi dip and padding techniques to improve the color strength. Effect of mordanting techniques and effect of various mordant on color strength of the dyed sample have been investigated. The results for dyeing are very encouraging.

Key words: Natural Dyes, Hemp, Cotton, Vegetable Dyes.

1.INTRODUCTION

Since dyeing is one of the most polluting steps in the entire textile process, using natural dyes instead of synthetic ones is thought to be quite interesting. Numerous biodegradable and renewable sources, including plants, animals, minerals, fungus, algae, microorganisms, and insects, can be used to extract natural hues. The inclusion of various functional groups in their structure gives all of these colors antiviral, antifungal, antibacterial, anti-allergic, antioxidant, and anti-UV qualities. Also, they are not harmful to the environment, non-toxic, non-poisonous, non-carcinogenic, or dangerous. Typically, dyes obtained from plants have no affinity for cellulose, so they need a mordant to permanently fix to the textile fibers, resulting in improved color and color fastness. Consequently, environmentally friendly mordants such as tannins and alum are necessary to make the dyeing process more sustainable and eco-friendlier.

1.1 Natural Dyes: Returning to nature's bounty, natural dyes derived from plants, insects, and even minerals are making a comeback. While the color palette may be more limited than synthetics, natural dyes offer a unique charm and often require less harsh chemicals for fixation. Madder root produces vibrant reds, indigo yields its signature blue, and turmeric lends a golden hue.

1.2 Bio-based Dyes: Biotechnology is opening doors to a new generation of dyes. Microorganisms like bacteria and fungi are being used to produce vibrant and colorfast dyes using renewable resources like plant sugars or even food waste. This reduces reliance on petroleum and offers a sustainable way to utilize waste products.

1.3 Low-impact Dyes: Synthetic dyes aren't entirely out of the picture. The focus is on low-impact dyes that require less water, energy, and chemicals during production compared to traditional options. Additionally, innovations in dye fixation techniques are minimizing the release of harmful chemicals into wastewater. As the name suggests, natural dyes are colorants derived from plants, animals (usually invertebrates), or minerals without the use of synthetic chemicals. Most natural dyes come from plant-based sources.

Natural dyes can be used with or without mordants. Mordants are substances that act like a fixing agent to help the natural dye bind properly to the fabric. These are also naturally produced through minerals. Each natural dye color requires a different mordant depending on how it was created. Today, the chemical industries around the world have challenges in protecting the environment, and synthetic dye-induced water pollution, particularly with regard to effluent control, remains an issue. Environmental rules around the world are getting more stringent, which is pushing technology to advance less. It is more critical than ever to understand the significance of natural dyes and investigate their technology. This ultimately resulted in a return to a more conventional or organic way of living. There is currently a push to dye fabrics with natural colouring materials as part of this trend. The use of natural dyes as textile colourants on textile substrates has been the subject of intensive research recently worldwide.

During the dyeing process, the majority of the dyes are absorbed by the substrate. The current work focuses on dyeing cotton utilizing two distinct natural dyes that contain tannins (Catechu and Hardaj) using the traditional pre, meta, and post mordanting methods. Additionally, we want to investigate how dye concentration and dyebath pH affect colour intensity. To investigate the impact of -\ COLD U RAG E ~ MARCH 2006 as well as the influence of mordant on colour strength and hue! If standing dyebath on colour strength. Applying natural dyes utilising the multi-dip approach and padding technique (i.e., cold-pad-batch and pad-dry-steam) is another goal of the current study.

2. MATERIALS AND METHODS:

2.1 Fabric: 112 ends, 72 picks per inch, and a weight of 118 gm/sq.mt. were utilized in this plain-woven, mill-scoured, bleached, and pure poplin cotton fabric that was bought from the local market. The fabrics were mildly treated in the lab using a solution that contained soap (2 gpl) and sodium carbonate (5 gpl) to purify them. After that, the fabric was carefully cleaned and allowed to air dry.

Cotton and hemp served as the raw materials. Lana y Telar (Sevilla, Spain) supplied the dyes and mordants employed in this investigation. Common madder powder (Rubia Tinctorum) and dried calendula (Calendula Officialis) flowers were used to make the dyes. Potassium alum crystal (KAl(SO4)2·12H2O) and fine tannin powder (C76H52O46) were selected as mordant agents. Scharlab (Sentmenat, Spain) provided the extremely pure sodium hydroxide (NaOH) and glacial acetic acid, VWR Chemicals provided the 50% w/v hydrogen peroxide (H2O2), and Merck provided the sodium carbonate powder ≥99.5%.

2.2 Natural colourants: For this investigation, the two natuniCdyes listed below were chosen. 1. Acacia catechu, or catechu 2. I Mordants Harda (chebula): Ammonium sulfate, copper sulfate, and ferrous sulfate were the mordants used for the project. These mordants were all of the laboratory reagent variety.

2.3 Mordants: Ammonium sulfate, copper sulfate, and ferrous sulfate were the mordants used for the project. These mordants were all of the laboratory reagent variety.

2.4 Mordanting tannin

In the Linitest containers, 300 mL of a solution containing 5 g of fabric and 8% tannin over weight fiber (% o. w. f.) were kept at 50–60 °C for one hour. Following the removal of the textiles, two alum mordantings were applied straight away.

2.5 Mordant alum

5 g of the fabric and 300 mL of alum 15% o.w. f. and sodium carbonate 2% o.w. f. solution were applied for 1 hour at 50–60 °C for the initial mordanting. Alum 10% o. w. f. and sodium carbonate 2% o. w. f. were employed in the same way for the second mordanting. In addition to its detergent qualities, this reagent was used with alum to control pH and enhance color absorption into the fiber. The fabrics were then allowed to air dry at room temperature.

2.6 Wet processing

Following the acquisition of the knitted fabrics, various procedures were used. This step's objective was to identify the best dyeing conditions for the fabric being utilized. The effects of the mordant agent prior to, during, and following dyeing, water hardness, dye type, and the outcome of a subsequent rinse were the factors that were examined.

2.7 Extraction of dye

a) Catechu: Catechin, often known as Natural Brown-3, was the primary colorant pigment found in cutch. The heart wood was then chipped after the bark and exterior sapwood were typically removed and rejected. The extraction process involved adding cold water. Charcoal is added to the red solution, which dissolves in hot water. The solution is then brought to a boil and, once hot, filtered. When catechin crystals are formed, the filtrate is cooled.

b) Harda: Commercial Harda powder from the local market was used for this experiment. 100 milliliters of hot water were used to paste five grams of harda powder, which was then thoroughly dissolved in the least amount of water possible. To obtain a clear solution, the solution was heated a little if needed. After filtering, water was added to maintain the final volume and achieve a strength of 1:50. This solution was then utilized as a stock solution for the duration of the project.

c) Calendula: First, the dye was extracted from the dehydrated flower of calendula. A solution containing calendula flower 40 g/L was prepared and boiled in a flask with a reflux condenser and magnetic stirring for 30 min. Afterward, 300 mL of the filtered dye solution and the fabrics were introduced into the Linitest vessels at LR of 1:60 for 1 h at 100 °C. Finally, the fabrics were removed and left to dry with or without further rinsing, depending on the case

3. RESULT AND DISCUSSION

This research successfully demonstrates the potential of using natural dyes in a sustainable and eco-friendly manner for dyeing hemp/cotton fabrics. The studies focused on two main areas: the use of calendula and common madder as natural dyes, and the exploration of dyeing methods that promote circular economy principles in the textile industry.

3.1 Dye Selection and Fastness Properties:

Both calendula and common madder proved to be effective natural dyes for hemp/cotton fabrics, contributing to the goal of reducing dependence on synthetic dyes. Calendula emerged as the superior option due to its excellent washing and rubbing fastness, indicating its ability to provide durable and long-lasting color on textiles. While both dyes provided strong color intensity, calendula was particularly notable for its higher resistance to fading and wear, making it a more sustainable choice for practical textile applications.

3.2 Mordanting and Dye Uptake:

The study highlighted the critical role of mordants in enhancing dye uptake and improving color fastness. The tannin-alum mordant combination was identified as highly effective, enhancing both dye absorption and the strength of the color on the fabric. The simultaneous mordanting and dyeing process, where the fabric was mordanted and dyed in a single step, was found to provide the most vibrant and consistent results, ensuring that the natural dye adhered well to the fabric and remained durable.

3.3 Dyeing Methods:

The investigation into different dyeing techniques revealed that the pad-dry-steam method produced the strongest color intensity on cotton fabrics. This method aligns well with sustainable practices by being energy-efficient and reducing water usage compared to traditional dyeing methods. It supports the use of lower-impact, environmentally friendly techniques, ensuring that natural dyeing processes are both effective and resource-efficient.

3.4 Sustainability and Circular Economy Implications:

Overall, both studies underscore the potential of integrating natural dyes and sustainable dyeing methods into the textile industry. The findings show that the use of calendula, common madder, and eco-friendly mordants, combined with energy-efficient dyeing methods like pad-dry-steam, can reduce the environmental footprint of textile production. These practices promote the principles of a circular economy by encouraging low-impact, biodegradable alternatives to synthetic dyes, reducing water consumption, and minimizing the use of toxic chemicals.

3.5 Discussion:

This research demonstrates the growing potential of natural dyes, specifically calendula and common madder, in the sustainable dyeing of hemp/cotton fabrics. The focus on natural dyes highlights their environmentally friendly alternatives to synthetic dyes, which are often harmful due to the chemicals involved in both the dyeing process and their disposal. As concerns about the textile industry's environmental impact grow, the findings of this study contribute valuable insights into creating a more sustainable and circular textile economy.

One key finding from the first study was the effectiveness of calendula as a natural dye, which offered superior washing and rubbing fastness when compared to other natural dyes, such as common madder. This makes calendula a promising candidate for long-lasting, eco-friendly textile dyeing. The fastness of dyes is a crucial consideration for textile manufacturers and consumers alike, as it ensures that the fabric maintains its color after repeated washings and wear. The superior fastness properties of calendula, therefore, make it not only a more sustainable choice but also a more practical one for everyday applications.

Furthermore, the research into mordanting techniques revealed that the use of tannin–alum mordants significantly enhanced dye uptake. Mordants are essential in natural dyeing, as they help the dye bind to the fibers, improving the overall color intensity and fastness. The simultaneous mordanting and dyeing process showed the best results in terms of color strength and fixation. This is an important consideration for the industry, as traditional dyeing processes can be labor-intensive and time-consuming. By combining the mordanting and dyeing steps, it is possible to streamline the process, which not only reduces resource consumption but also aligns with the goals of circular economy principles.

The second study's focus on the pad-dry-steam method for applying natural dyes to cotton fabrics revealed significant advantages over other dyeing techniques. This method resulted in stronger and more intense colors, which is a crucial factor for the textile industry when it comes to creating appealing fabrics. The pad-dry-steam technique is an efficient and cost-effective method that minimizes water and energy consumption, further supporting the industry's sustainability goals.

Given the growing interest in eco-friendly dyeing technologies, this method provides a valuable approach for integrating natural dyes into mass production while maintaining high-quality results.

The importance of sustainable textile processing practices, such as using natural dyes and efficient dyeing methods, cannot be overstated in the context of the global textile industry's ecological footprint. The textile sector is one of the largest contributors to water pollution and waste, primarily due to the extensive use of synthetic dyes and harmful chemicals in the dyeing process. By shifting toward natural dyes and adopting cleaner, more efficient dyeing methods like pad-dry-steam, manufacturers can reduce their environmental impact and contribute to a more circular and eco-friendly textile industry.

This research not only underscores the viability of natural dyes in the textile industry but also emphasizes the importance of optimizing dyeing techniques to achieve both environmental sustainability and practical performance. By incorporating natural dyes like calendula and madder, along with innovative dyeing methods and mordants, the textile industry can move toward a more sustainable future. These findings advocate for the adoption of circular economy principles, which prioritize reducing waste, conserving resources, and reusing materials in closed loops, ultimately benefiting both the environment and the industry itself.

4. CONCLUSION

The analysis of results, it has been possible to show that a fabric containing a residual non-textile industrial hemp is susceptible to be dyed using natural dyes. In this way, a more sustainable process has been established that contributes to the circular economy of the textile chain.

The mordant is an important variable for this type of dyeing and the results showed that the tannin–alum combination was effective. The type of water used in the mordanting process also influenced the results, with better values when tap water was used. Meta-mordanting proved to be the most appropriate for these types of dyes and mordants. When mordanting was carried out simultaneously with dyeing, the number of reactions between the different components of the bath with the substrate was greater, favoring the absorption of the dye by the cellulosic fibers.

The typical madder dye produced a somewhat larger color range than calendula when examining the impact of several dyes on fabric. However, because of its improved wash and rubbing fastness, calendula turned out to be a preferable choice for dying hemp/cotton fabric. Waiting at least twenty-four hours before rinsing is advised. Mildly alkaline circumstances increased the color power of vegetable dyes such as harda and catechu. For cotton fabric, the pad-dry-steam approach outperformed the coldpad-batch and exhaust procedures in terms of color strength. Furthermore, the application of metallic salts provided a wider variety of hues in addition to intensifying the color. With or without mordants, both vegetable dyes demonstrated good light, wash, and rubbing fastness.

This research comparatively highlights the potential of using natural dyes, such as common madder and calendula, to dye hemp/cotton fabrics in a sustainable manner. The tannin–alum mordant combination was found to be effective in enhancing dye uptake, with the simultaneous mordanting and dyeing process yielding the best results. While both dyes provided good color intensity, calendula offered superior washing and rubbing fastness, making it a more durable option for textile applications. Additionally, the study confirmed that the pad-dry-steam dyeing method produced the best color strength compared to other methods, further supporting the potential of sustainable dyeing practices in the textile industry. These findings contribute to the promotion of circular economy principles by encouraging eco-friendly, low-impact dyeing techniques.

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SMART CONTROLLABLE BLUETOOTH VIBRATING MASSAGER CAP FOR SCALP STIMULATION AND HAIR LOSS PREVENTION

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ABSTRACT

An innovative hair care product that enhances scalp health and may prevent hair loss is a vibrating massage cap that connects with Bluetooth. Comfort and durability are ensured by the cap construction from high-quality materials such medical-grade silicone, ABS plastic, and soft rubber. The device's high-frequency motor produces gentle, constant vibrations that encourage scalp health, boost blood flow, and strengthen hair follicles. Using Bluetooth technology, users may connect the headgear to a smartphone app for more control and personalization. Customers may adjust the vibration intensity, set up massage programs, track usage, and receive reminders using their tablet or smartphone thanks to this connectivity. Additionally, several versions provide programmable vibration levels, allowing users to customize the experience to their liking, whether they like a gentle relaxation massage or more intense scalp stimulation. The cushioned construction and gentle massaging tips of the hat ensure comfort while promoting relaxation and reducing stress, which is often linked to hair loss. Regular use of the intelligent features and constant vibration therapy of the vibrating massage cap can improve circulation, strengthen hair growth, and improve the overall health of the scalp.

INTRODUCTION

The ability of textiles to perceive and react to changes in their surroundings is known as "smart textiles." They fall into two categories: passive smart textiles and active smart textiles. When stimulated by their surroundings, passive smart fabrics can alter their characteristics. This group includes materials with shape memory, hydrophobic or hydrophilic text tiles, etc. Active smart textiles are equipped with sensors and actuators that link the broadcast message to internal characteristics. To determine how to respond and ultimately take action, they can use a variety of textile-based, flexible, or miniature actuators (textile displays, micro vibrating devices, light-emitting diode (LED), organic light-emitting diode, etc.) that can detect various environmental signals, such as temperature, light intensity, and pollution. The "decision" can be made locally, as in the case of textile electronics incorporated in smart textile structures, or remotely, as in the case of smart textiles wirelessly connected to servers running artificial intelligence software, databases, and other cloud-based systems.

In today's fast-paced world, stress and anxiety are prevalent and can negatively affect people's mental and physical well-being. Head massages and other traditional relaxation methods have long been valued for their ability to promote calm and ease tension. Customers may access and operate the head massage system remotely thanks to the seamless integration with mobile devices made possible by the Bluetooth controller connectivity. At the heart of the head massager cap is the vibrator module. Inside the gadget, it is placed in a calculated method of applying vibrations to certain scalp pressure points. In addition to promoting relaxation and stress relief, strengthen hair follicles and these vibrations also improve blood circulation.

By adjusting the vibration settings to suit their preferences, users can personalize their massage experience. The head massager features a vibrator module as well as rotors that mimic the kneading motion of human fingers.

A variety of techniques are used in a head massage in order to relieve tension and lower stress in the upper body. By massaging the blood vessels and nerves in the area, scalp massage can help reduce tension in the muscles supporting the head. Receiving a head massage can be both refreshing and relaxing.

MATERIAL:

ABS PLASTIC:

Acrylonitrile Butadiene Styrene, or ABS plastic, is an opaque thermoplastic amorphous polymer that is frequently utilized in a variety of manufacturing sectors. Styrene, butadiene, and acrylonitrile are the three monomers that make up ABS plastic, a terpolymer. Hardness, stiffness, fatigue resistance, and a higher heat deflection temperature are all influenced by acrylonitrile. While styrene improves surface properties, hardness, rigidity, and processability, butadiene adds toughness and ductility at low temperatures.

RUBBER:

Rubber can be used in many different applications since it is a strong, long-lasting material that is flexible, resistant to abrasion, and has the capacity to distort and then regain its original shape. Although there are several varieties of rubber, they are often divided into two primary groups: synthetic and natural. While synthetic rubber is produced through a chemical process, natural rubber is derived from plants.

Medical-grade silicone:

Every tool used to assist patients in the medical industry should be of the greatest quality and absolute safety. Medical grade silicone is a popular option for medical equipment and seals because of this. Silicone has been classified as "medical grade" and suitable for use in important uses following extensive testing for USP standards, ISO, and FDA certification. Medical grade silicone is a reliable substance that may be applied to a variety of tasks because it is non-toxic, strong, and incredibly adaptable.

METHODOLOGY

Product Conceptualization and Design

The product targets individuals experiencing hair loss, those seeking scalp health, and relaxation. It focuses on improving circulation, promoting relaxation, and enhancing well- being. User research is key to understanding preferences and comfort needs. The device features an ergonomic, lightweight cap that fits various head sizes, with soft silicone or rubber massage tips for scalp stimulation. A padded interior with memory foam or soft rubber ensures comfort for extended use, delivering an effective and soothing scalp care experience.

Material Selection

Medical-Grade Silicone: Used for massage tips and inner lining, offering hypoallergenic, flexible, and soft properties, safe for skin contact.
ABS Plastic: Chosen for the external body, lightweight and durable to house the motor and Bluetooth components.
Soft Rubber: Incorporated for extra cushioning and comfort in the outer rim and padding for a snug fit.

Vibration Technology Integration

High-Frequency Motor: A small, powerful motor that delivers low-intensity vibrations to effectively stimulate the scalp.
Vibration Patterns: Multiple settings (gentle, moderate, intense) to suit different preferences.
Motor Housing: A secure, silent compartment within the ABS shell to house the motor.
Bluetooth Connectivity and App Development
Bluetooth Module: Enables communication with smartphones or tablets.
Smartphone App:
Design: Easy-to-use app for iOS and Android to control the device.
Customization: Adjust vibration, select modes
Progress Tracking: Monitor scalp health improvements, blood circulation and hair density.

Manufacturing and Assembly

Prototyping: Make models to test functionality, comfort, and vibration efficiency.
Purchasing Materials: Purchase premium, medical-grade silicone, soft rubber, ABS plastic, and vibration motors from reliable vendors.
Assembling the Cap: Put the soft rubber or silicone parts, Bluetooth module, and high- frequency motor together. Make sure the vibration motor is firmly in position and that wearing the device is pleasant.

TESTING METHOD:

Testing for Material Durability and Safety:

Make sure medical-grade rubber and silicone are free of allergies and safe for skin contact by conducting hypoallergenic testing.
Durability: Examine the rubber, silicone, and ABS plastic used to make the caps for deterioration and their capacity to tolerate repeated use.
Water and Sweat Resistance: Verify that the gadget can withstand wetness to make sure it's safe to use in a variety of settings.

Performance Testing:
Motor Functionality: Test the motor for smooth, consistent vibrations at different intensities. Ensure it operates quietly and efficiently.

Bluetooth Connectivity: Ensure the Bluetooth connection is stable and works seamlessly with the smartphone app across both iOS and Android platforms.

Comfort and usability Testing
Comfort and Fit: Assess the comfortable construction of the cap to make sure it fits heads of all sizes snugly.
To ensure comfort during continuous usage, test the massage tips' and padding's softness.
Pressure Distribution: To prevent discomfort, check how well the cap spreads pressure from the massage tips.

Functionality Testing of Apps:
The user interface (UI): Make sure the software is easy to use, intuitive, and works properly with a variety of devices.

Control and Personalization: Examine how well you can set timers, change the massage modes, and modify the vibration intensity.

Evaluation of Effectiveness:
Scalp Health: Over a predetermined time period, evaluate the product's effects on blood circulation, hair growth stimulation, and general scalp health.

Hair Growth: Measure the impact on hair growth or the prevention of hair loss by conducting controlled testing or research studies.

Stress Reduction: Assess the gadget's capacity to ease tension and promote relaxation, possibly connecting it to better hair health.

User Feedback and Usability Testing:
Comfort and Ease of Use: Gather feedback from users regarding comfort, ease of use, and effectiveness.
Long-Term Use: Test how the device holds up after repeated use and if the app remains functional over time.

CONCLUSION

The vibrating massage cap is a ground-breaking method of improving scalp health and maybe preventing hair loss. It offers consumers a customized and efficient way to increase circulation, stimulate hair follicles, and encourage relaxation by integrating cutting-edge technologies including high-frequency vibrations, Bluetooth connectivity, and adjustable settings. Comfort and longevity are guaranteed by the cap's construction from premium, long-lasting materials including ABS plastic and medical-grade silicone. For those looking for healthier hair and scalp care, this revolutionary product is a useful and entertaining tool because it can assess progress, change intensity, and provide therapeutic benefits.

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ADVANCES IN THE ECOLOGICAL INDUSTRY

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ABSTRACT

The need for sustainable textiles has grown as a result of ecological depletion, and environmental problems in the textile sector are getting worse every day. Sustainable textiles have made a significant global impact on reducing environmental issues. The textile industry are benefiting from the rise of sustainable fabrics. The advances related to sustainable textiles are discussed in this article. Future generations will benefit from sustainable items that have a longer lifespan. Some studies are still being conducted to create new eco-friendly textiles. Ethical ideas have been presented to promote the use of sustainable textiles in order to improve societal well-being. Materials and production methods used to create fabrics that reduce their negative effects on the environment, preserve resources, and encourage moral behavior are referred to as sustainable textiles. These textiles are a component of the larger trend in the fashion and textile sectors toward sustainability. Sustainable textiles are essential for encouraging moral behavior and long-term resource conservation while lessening the textile and fashion sectors' environmental impact.

Keywords: sustainable textiles, ecological depletion, global impact, Ethical ideas

INTRODUCTION

The word "sustainable" was first used in 1987 and evolved in 1992.In 2000, care ethics paved the way for the creation of sustainable textiles.Global green is the aim of sustainable fashion. Due to consumers' increased moral concern, the market for sustainable textiles peaked. Economic, social, institutional, and environmental facets of human existence are interconnected with the natural ecosystem. Sustainability’s impact on the earth as a whole, not just its neighbors. Sustainable development satisfies current demands without interfering with the ability of future generations to satisfy their own. Animal hides were used to make leather in the past. Customers are more conscientious than ever in the modern world, and they anticipate eco-friendly items from the businesses they buy. Additionally, there are no indications that this tendency will slow down.

ADVANCES IN THE ECOLOGICAL INDUSTRY

APPLE LEATHER

Italy is the birthplace of apple leather, which was manufactured in 2004. Through Albert Volcan.Apple skin is used in the production of this bio-based substance. Because it is renewable, it lessens the effect of CO_2. Apple trash, which is gathered from the fruit juice business, has a high cellulose content. The powdered apple skin is mixed with polyurethane to create supple, long-lasting apple leather. It is employed in the production of purses and footwear.

Made from the residual apple trash (such as cores and peels) produced during the preparation of apple juice, apple leather is an environmentally beneficial and sustainable product. It's a part of a growing trend that uses plant-based materials to provide alternatives to traditional animal leather.

Qualities:

1. Durability: On par with conventional leather, it can be used for accessories, upholstery, and fashion items.
2. Sustainability: Utilizes fewer resources and less agricultural waste than the manufacturing of animal leather.
3. Vegan and Cruelty-Free: This product appeals to vegan and eco-conscious customers because it doesn't include any animal products.
4. Versatility: Suitable for wallets, purses, shoes, and even automobile interiors.
5. Aesthetic Appeal: With changeable textures and colors, it can replicate the appearance and feel of real leather.

The Manufacturing Process:

1. In the process of making cider or juice, apple trash is gathered.
2. A fine powder is created by drying and processing the waste.
3. The powder creates a long-lasting, leather-like substance when mixed with additional natural or synthetic binders.
4. The material is polished, sculpted, and dyed for different uses.

As the fashion and leisure industries move toward more sustainable practices, this cutting-edge material is becoming more and more -liked.

LEATHER FROM TEAK LEAFS

An environmentally responsible and sustainable substitute for conventional animal leather is leather derived from teak leaves. In order to produce a strong, pliable, and visually pleasing material for a range of uses, teak leaves are used. This is an explanation of how it operates.

Important Characteristics of Teak Leaf Leather

1. Eco-friendly: Makes use of renewable and natural resources.
2. Sturdy: Suitable for accessories like wallets, purses, and shoes, this material is robust and resilient.
3. Aesthetic Appeal: The material has a distinctive and organic appearance due to the organic patterns found in teak leaves.
4. Vegan: A cruelty-free substitute for leather derived from animals.

Production Method

1. Harvesting Leaves: To protect the plants, mature teak leaves are gathered, typically from fallen foliage.
2. Preparation: To preserve their natural properties, the leaves are cleaned, dried, and processed.
3. Bonding: Non-toxic glues are used to stack leaves on a backdrop of fabric, usually composed of recycled or organic cotton.
4. Sealing: A waterproof and UV-resistant sealant, frequently composed of plant-based resins, is applied to the surface.
5. Finishing: The material is cut and sewn into a variety of goods after being dyed or left unaltered.

Teak Leaf Leather Fashion Uses: Belts, wallets, and handbags. Footwear: Sandals and shoes suitable for vegans. Home décor includes pillow coverings, coasters, and more. Office supplies that are environmentally friendly, such as notebooks. Teak leaf leather's distinctive look and environmental advantages are making it more and more popular in sustainable design marketplaces.

PINA LEATHER

Often referred to as "pineapple leather," piña leather is an environmentally responsible and sustainable substitute for conventional leather. It is an inventive material for the fashion and accessory industries since it is manufactured from the fibers of pineapple leaves, which are normally agricultural waste. Pina leather was created in the 17th century in the Philippines. Collecting and drying fallen pine apple leaves was done. When drying occurs, pectin is liberated. The leaf is made rigid by this chemical. The leaf becomes pliable and resilient after the pectin is eliminated. After that, the leaf undergoes a polylactic acid treatment, turning it into non-woven mesh. Because of its softness and durability, pina leather is used to make footwear, bags, and other items.

Piña Leather's characteristics include:

1. Sustainability: Using fibers from pineapple leaves, it promotes a circular economy and lessens agricultural waste.
2. Durability: It is strong and appropriate for goods like upholstery, purses, and shoes.
3. Vegan-Friendly: Since no animal products are used, this is perfect for ethical fashion labels.
4. Versatility: Similar to regular leather, it may be dyed and processed to provide a variety of textures and finishes.

Uses: Wallets, shoes, and handbags are examples of fashion accessories. Furniture: Sofa and chair upholstery. Clothing: Belts and jackets. If you want to lessen your influence on the environment without sacrificing quality or design, piña leather is a great option.

DESSERTO LEATHER

Desserto leather, sometimes referred to as cactus leather, is a creative, environmentally responsible, and sustainable substitute for conventional animal leather. Because of its durability and low environmental effect, this material, which is made from the mature leaves of the Nopal (prickly pear) cactus, is becoming more and more popular in the fashion and upholstery industries.

Important attributes:

1. Ecological Manufacturing: Without irrigation, the cactus is grown organically. Harvesting only fully grown leaves permits the plant to regrow. The production procedure does not involve the use of PVC, phthalates, or hazardous chemicals.
2. Advantages for the Environment: less water-intensive than leather or synthetic substitutes. Cruelty-free and biodegradable. Low environmental impact and carbon-efficient manufacture.
3. Sturdiness Similar in texture and durability like animal leather. Resistant against UV radiation, abrasion, and rips. Enduring last about ten years if properly cared for.
4. Utilization: Fashion: wallets, purses, belts, shoes, and jackets. interiors of cars and upholstery for furniture. phone cases and watch bands, for example. 5. Benefits Over Conventional Leather: moral and devoid of malice. lighter and better at breathing. supports environmentally friendly methods.

Manufacturers of Cactus Leather:

Numerous businesses are using cactus leather in their goods, including high-end and eco-friendly fashion labels. Desserto is the top manufacturer, working with brands all over the world to develop environmentally friendly designs. More information about certain businesses or goods that use cactus leather would be helpful.

MYCELIUM LEATHER

A creative and sustainable substitute for leather derived from animals is mycelium leather, or leather created from mushrooms. A rapidly growing and renewing substance, mycelium is the root structure of fungi from which it is generated.

The Manufacturing Process

1. Culture: Mycelium is cultivated in regulated conditions on a substrate, such as agricultural waste. It forms a dense mat of interwoven fibers as it grows quickly.
2. Processing: The mycelium is harvested, processed, and tanned to produce a substance that resembles leather after it reaches the appropriate size and thickness. Texture and color can be achieved by applying natural dyes and finishing techniques.
3. Customization: The finished item can be designed to have distinctive textures or to resemble or feel like real leather.

Benefits Sustainability:

Compared to regular leather, the production of mycelium leather consumes less energy and water and produces less waste.

Eco-friendly: It lowers greenhouse gas emissions and does away with the necessity for animal husbandry.

Biodegradability: Unlike synthetic leathers composed of plastic, mycelium leather decomposes naturally.

Customization: It reduces material waste by being able to be grown and shaped to particular textures and shapes.

Uses Fashion:

Applied to accessories, jackets, shoes, and purses. Furniture: Upholstery for couches, chairs, and other pieces of furniture. Automotive: Eco-friendly automobile interiors. Well-known Developers and Brands With goods like Reishi and Mylo, MycoWorks and Bolt Threads are leaders in the creation of mycelium leather. Mycelium leather is already being used by Stella McCartney and other luxury fashion labels in their creations. This invention satisfies the rising need for environmentally friendly

VEGAN LEATHER

Often referred to as "grape leather" or "vegan leather," leather manufactured from grapes is a novel, environmentally friendly substance made from the skins, seeds, and stems of grapes used in winemaking. It is a component of the expanding movement to develop environmentally friendly substitutes for conventional animal leather.

Essential Qualities of Grape Leather:

1. Sustainability: It lessens the environmental effect of both winemaking and leather manufacture by reusing agricultural waste.
2. Cruelty-free and vegan: No animals are used in its manufacture.
3. Durability: It can be produced to have the strength and flexibility of conventional leather, depending on the manufacturing technique.
4. Biodegradable: In contrast to synthetic leathers, several types decompose more naturally or can be composted.

Manufacturing Procedure:

Collection: Pomace, or leftovers from winemaking, is collected.

Processing: The substance is cleaned, dried, and combined with organic binders to create a layer that resembles leather.

Shaping: To replicate the look and feel of leather, sheets are textured, dyed, and honed. **Uses:**

Uses for grape leather include: Bags Jackets and Shoes Furniture Wallets Grape leather was invented by companies like Vegea, and they are collaborating with fashion and luxury brands to use it in high-end goods.

LEATHER FROM COCONUT

An inventive and environmentally friendly substitute for conventional animal leather is coconut leather. It entails turning discarded coconut—especially the fibers and husks—into a long-lasting, environmentally beneficial substance. This procedure fits into the expanding trend of using plant-based materials in upholstery and clothing.

Making Coconut Leather:

1. Gathering of Coconut Waste: Byproducts, such as coconut husks, are gathered, frequently from the food or coconut oil industries.
2. Processing To create a flexible sheet, the fibers are mixed with natural or synthetic binders after being cleaned and processed.
3. Tanning and Coloring: The feel and look of leather are achieved by using environmentally friendly dyes and finishing methods. The material undergoes a final treatment to improve its flexibility, water resistance, and durability.

Coconut leather advantages include:

Eco-friendly: minimizes dependency on animal-based products and makes use of agricultural waste. Environmentally friendly: Uses less energy and water than conventional leather manufacture.

Biodegradable: It takes less time to break down than synthetic leather, depending on the binders used. Cruelty-free: Provides vegan options for those who are concerned.

Uses: Fashion items, such as purses, wallets, and shoes. upholstery for vehicle seats and furniture. objects for decoration (book covers, lampshades). Due to its creative method of minimizing waste and its influence on the environment, coconut leather is becoming more and more popular in sustainable fashion and product design.

CONCLUSION

Our natural environment is the foundation of everything we need to survey on this world. Therefore, it is our duty to set an example for sustainability so that future generations can live healthy lives. The sustainable practices of even well-known industries were altered. This is a representation of progress that protects natural ecosystems and biodiversity. Natural textile advances in today's environment provide clients with therapeutic benefits. Thus, there is a need for durable clothing.

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REVIEW OF ORGANIC POTTERY USING NATURAL TEXTILE WASTE

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ABSTRACT

This research investigates the design and production of pottery using organic waste and provides new techniques for sustainable potterys. It aims to reduce waste and create environmentally friendly products using waste products, not only reducing the impact on the environment but also creating beautiful products.

To create an efficient and renewable product method by experimenting with natural fibers, that incorporate the principles of regeneration, renewal and harmony with nature. Finally, this research focuses on developing sustainable construction by providing innovative solutions for the future. Similarly, the pottery industry has an impact on the environment, mainly due to the use of synthetic materials, energy-intensive production processes and waste generation. This method helps to replace the Pots,Bags and Hangers which is made up of Plastic and reducing the usage of the Plastic. In the pot, no Chemical Additivves were used. Due to its organic nature, it benefits the plant by providing Additional Supplements which enhance the growth of the plant.

Organic pottery embodies the principles of circular economy, regeneration, biodegradability and harmony with nature. In addition, this research to contribute to the development of design, to stimulate new solutions and to adopt good environmental practices by encouraging new strengths of professionals and businesses, ultimately creating a better environment for everyone, a resilient and sustainable future.

KEY WORDS

Eco Friendly products, Upcycling textile wastes, Sustainable growth, Biodegradable pottery.

INTRODUCTION

Every Natural Resources on Earth have their own Decomposition properties. However, man-made materials take years to decompose. The soil itself loses its fertility due to things that do not decompose. Gardening plays an important role in increasing the life expectancy of humans and animals. Horiculture plays an vital role in increasing of plants and conserves natural resources. To cope with modern society and maintain soil fertility, this project provides horticultural techniques. Since gardening is based on horticulture, it will be suitable for improving gardening and maintenance ideas. This project aims to create and produce organic flower pots by combining organic farm waste and natural shredded textile waste. By recycling these materials, we can reduce the waste problem and create a unique eco-friendly product for the horticultural sector. The flower pots are fully compostable, reducing plastic pollution and promoting sustainable agriculture.

Designing and manufacturing organic pottry from waste products provides a unique opportunity to create new, environmentally friendly products that reduce waste and environmental impact. This research has the potential to contribute to the development of design, promote environmentally friendly practices, and support a new wave of professionals and businesses.

TEXTILES

Textiles have been an integral part of human civilization for thousands of years, playing an important role in our daily lives from clothing to interior decoration to industrial use. The textile industry is a significant part of the global economy, employing millions of people and generating significant revenues. The world of textiles is a complex and fascinating one encompassing many fibers, manufacturing processes and uses. In this study, we will understand the history of textiles, types of fibers, manufacturing processes, textile usage, sustainable textiles and the Indian textile industry.The early textile industry was characterized by hand spinning, weaving, and dyeing techniques. The Indus Valley Civilization in India is famous for its fine cotton. The Industrial Revolution marked a turning point in the textile industry with the introduction of spinning machines and looms. This led to increased textile production and increasingly affordable fabric for the masses.

From fiber production to waste materials, the textile industry has an impact on the environment. Sustainable textiles aim to reduce the impact of environmental materials, reduce waste, save energy and operate fairly. Eco-friendly materials include organic cotton, polyester and plant dyes. Waste production can be reduced through production, recycling and zero waste.

OEKO TEXTILES

Oeko Textiles has become a key player in the textile industry, reflecting the growing focus on sustainability and ethical manufacturing practices. Founded on the principles of transparency and environmental responsibility, the company promotes the use of sustainable materials and innovative production techniques that minimize waste. This shift coincides with increasing consumer demand for ethically sourced products, as evidenced by recent research that highlights that consumers are willing to pay more for sustainable options, even across borders .

In addition, Okeo Textiles not only contributes to environmental sustainability, but also addresses systemic issues in the industry, such as labor rights and supply chain transparency . Based on cutting-edge design approaches that combine sustainability and traditional craftsmanship, Okeo Textiles sets a benchmark for others in the industry while maintaining ecological integrity and social responsibility. As such, the company plays a crucial role in shaping future trends in textile production and consumption. The study of ecological materials and production processes is essential in the context of sustainable textiles, especially in the field of Oeko-Tex textiles.

From fiber production to waste materials, the textile industry has an impact on the environment.Sustainable textiles aim to reduce the impact of environmental materials, reduce waste, save energy and operate fairly. Eco-friendly materials include organic cotton, polyester and plant dyes. Waste production can be reduced through production, recycling and zero waste.

The importance of sustainability has been emphasized through educational initiatives, highlighting a growing recognition of the need for ecoeducated consumers in the textile industry. As industries adapt to these environmentally friendly practices,they must also address the sustainability education gap, ensuring that future professionals are equipped with the knowledge necessary to promote sustainable environmental management throughout their careers.

The influence of Oeko-Tex textiles on contemporary fashion trends extends far beyond sustainable practices, including a broader cultural shift towards ethical consumption. As consumer awareness of environmental issues and labor practices increases, brands that commit to Oeko-Tex certification are often perceived as more responsible and trustworthy. The association has encouraged designers to integrate Oeko-Tex fabrics into their collections, thereby strengthening their appeal to environmentally conscious consumers. In addition, the versatility and quality of these fabrics correspond to the growing demand for durability and functionality in fashion, challenging the traditional fast fashion model. As a result, designers are now combining aesthetic innovation and sustainable materials, redefining modern fashion narratives. Integrating Oeko-Tex fabrics not only promotes environmental protection, but also fosters critical dialogue about the future of fashion, signaling a transformative moment where style, ethics and sustainability coexist in harmony in consumer culture.

NATURAL TEXTILE WASTE

Natural textile waste refers to waste material generated during the production of natural fibers like cotton, hemp, flax, and silk. These industries focus on eco-friendly practices, using no hazardous chemicals, synthetic dyes, and pesticides that are so often used in regular textile manufacturing. Rather, they embrace sustainable practices (organic farming, natural dyeing, mechanical processing) to produce in an environmentally sound manner good natural fibers.Such industries yield waste that is biodegradable in nature and is non-toxic, making it an ideal applications like Organic Pottry, Composting, and Natural textiles. Cotton waste from Organic cotton production, for example, is compostable and can be used to make a Natural Fertilizer, while Hemp waste can be made into animal bedding or construction materials. Likewise, flax waste can be turned into both paper products, while silk waste makes for excellent natural dyes or cosmetics.

This approach can also support the development of a circular economy, where waste is treated as an asset rather than a burden. As consumers become more aware of the environmental and social impacts of their purchasing decisions, the increasing demand for quality, environmentally friendly products is driving innovation and growth in the sector, where natural and chemical-free processes are at the forefront. The conversion of natural textile waste into pottery also provides artisans and designers with the opportunity to experiment with new materials and ideas, to push the boundaries of pottery and to create new and useful products for the consumer environment. Using waste energy in pottery has environmental benefits as well as health and financial benefits. For example, it provides artisans and designers with the opportunity to earn money from their craft while also promoting sustainable livelihoods and reducing poverty. Here some of the natural textiles are :

Cotton - It is one of the most produced and used natural fibers worldwide.

Linen - A natural fiber, is a type of fiber used in clothing and furniture textiles.

Hemp - It is known for their exceptional durability and strength, making them ideal for producing high-quality textiles

Jute - A biodegradable and compostable fiber used to produce textiles, paper, and other products.

Silk - A natural protein fiber produced by silkworms, used to produce high-quality textiles and clothing.

Coconut fibers: A natural fiber obtained from coconut husks, used to produce textiles, ropes, and other products.

ORGANIC WASTE

Organic waste, including agricultural and farm waste, constitutes a significant waste stream in India. It is estimated that more than tonnes of organic waste is generated in the country every day. Much of it is burned or dumped in landfills, causing air and water pollution. To address these issues, new strategies for agricultural waste management are being explored, including composting.For example, composting involves the decomposition of organic waste, creating nutrient-rich soil amendments that can improve soil fertility and involves the breakdown of organic waste in the absence of oxygen, producing valuable nutrients that can be used as biogas and fertilizer. To manage agricultural waste, creating superior products that improve soil health and fertility.Recycling textile waste is important to reduce waste dependency and promote a circular economy. It provides a comprehensive overview of sustainable waste management practices and highlights the urgent need for new methods to manage waste effectively. Its findings highlight current limitations and future directions for recycling, including the recovery of valuable fibres.

By implementing these sustainable waste management practices, farmers can reduce their environmental footprint, improve soil health, and generate additional income by selling compost and biogas. Furthermore, the integration of agricultural waste management with traditional practices such as organic farming can contribute to urban ecosystem services, biodiversity, and livelihoods. Therefore, priority should be given to the development and implementation of organic waste management strategies that not only reduce environmental and health risks but also support agriculture and rural development.The vast majority of this waste consists of agricultural and natural textile waste from the industries. When organic waste is not managed properly, it can lead to environmental pollution, health hazards and economic losses. However, with the right approach, organic waste can be converted into valuable resources, providing many benefits to the environment, economy and people**.**

REVIEW OF LITERATURE

Organic waste recycling is the process of organic waste management where organic wastes are recycled or converted into useful matter by different recycling methods. Organic recycling may offer the material a new lifecycle. The biobased textile wastes have a high potential to serve as an alternative feedstock for production of biological products via bioconversion of the cellulosic part of the textiles, which remained after the bioconversion as a purified value-added product. Although, organic recycling may offer the materials a new lifecycle, this is limited by the large variety of fibers and colors used in fabrics, which present challenges for the sorting processes and decrease the quality of the recycled materials . For any kind of reuse of textiles, they have to be collected separately from residual waste and sorted. Therefore, to increase the use of recycled material, there is a need for an economically viable and effective way to recognize and sort textile materials.

Manual sorting of textile waste based on the fiber material content listed on product labels is possible but slow and often unreliable, because the labels may have been removed, be worn out or have faulty information . Manual sorting is used to separate textiles by color, dye color, fabric type, quality and style. Biodegradable textile fibers can be defined as materials obtained from nature or by a synthetic route whose chemical bonds can be cleaved by enzymes. The suitability of such materials for a specific application will be dictated by their mechanical properties and their degradability. Most biodegradable textile materials, including composites, degrade within 2 weeks to 6 months .

The biodegradability of textiles is most likely influenced by their crystallinity, degree of orientation, degree of polymerization (DP), hydrophilicity/hydrophobicity, the condition of the soils where they are buried, and the species of microorganisms. To biodegrade natural fabric samples (cotton, jute, linen, wool), two methods have been used: a standard method in which textile materials were directly degraded in soil, and an indirect method (non-standard method) in which the materials were sewn in bags and exposed to soil. The time required to biodegrade fibers containing cellulose can vary.

Biodegradation of linen was fastest, which was connected with the structure of the linen fabric, whereas the degree of biodegradation of a linen/PET (poly(ethylene terephthalate) (PET) blend material was lowest, which was also linked to the structure of the material and the fact that the linen was blended with PET, which showed no effects of degradation. Wool is rather resistant to the attack of microorganisms because of its molecular structure and its surface. These two factors make it quite difficult for the microorganisms to penetrate the structure of the wool and biodegrade it . Rapid fabric biodegradation is facilitated by moist, warm aerobic soil conditions; under these conditions, the half-lives of rayon, cotton and Tencel® were 22, 40, and 94 days, respectively **(Magdalena Zaborowska).**

The biodegradable pots for seedling transplanting were tested in real field condition during 2009. The test was carried out inside a steel-constructed greenhouse (30.00 m × 10.00 m), North-South oriented, at the experimental farm. Period from seeding to seedlings transplanting, the irrigation was provided 3 times per day for 4 min at a time. On August 25, 2009 the seedlings together with the biodegradable pots were transplanted in the soil, without transplant shock. All the biodegradable pots showed sufficient mechanical resistance to guarantee material functionality. All the biodegradable pots remained intact through- out the entire period of 35 days from seeding to seedlings transplanting: the parts of the pots in contact both with the air did not show visual biodegradation. In this period the pots were subjected to a mean greenhouse air temperature of 31.6 ◦C and to a mean greenhouse relative humidity of 53.8%.
The Biodegradable pots allowed the development of the root structure with good branching structure. Wastes and by-products of agro-food industries and paper–textile manufacturing companies, such as tomato peels and seeds, and hemp, were glued with sodium alginate in order to produce biodegrad-able pots for plant transplanting in agriculture, thus aiming both to reduce such wastes and also to fight the accumulation of plastic pot wastes produced in plant nurseries.
To this aim, mechanical tests, water vapour permeability tests, water up-take evaluations and morphological analysis were carried out. It was found a strong physical interaction between sodium alginate and calcium ions in the development of a three-dimensional network. The crosslinked structure was able to physically entrap the reinforcement fibres by dimeans of hydrogen bonding, as evidenced by scanning electron microscopy (SEM) and energy-spersive X-ray spectroscopy (EDS) analysis. SEM analysis performed on fracture surfaces of the biocomposites evidenced that the fibres were well embedded inside the three-dimensional network, even if their dis-persion needed some improvements; EDS analysis revealed the presence of calcium in rather all the selected internal micro-zones, thus suggesting a well structured network. In order to assess the agro-nomic performance of the novel biodegradable pots in seedling transplanting activity**. (Evelia Schettini & et all).**

In the process of production and operation of family farms, a large amount of agricultural waste, such as livestock and poultry manure, has not been effectively treated in time, causing serious pollution to the environment. Moreover, livestock and poultry manure are the kind of resources that can be recycled to fertilize crops, which can benefit family farms both economically and environmentally. Adoption of manure biogas digesters by family farms can improve sustainability by not only decreasing input use and resource losses, but also reducing environmental pollution.

Finally, based on our proposed model, we make a two-dimensional analysis on the internal resource cost and external environment damages for agricultural-waste recycling. Our analysis shows that visualization of monetization of resource losses can optimize manure recycling through better decision-making, which can increase the sustainability of family farms. With the rapid development of modern agriculture, the shortage of agricultural resources is getting more serious. At the same time, increasing agricultural waste has contributed to pollution of rural environments. Resource constraints and environmental pollution have challenged the sustainable development of agriculture. Sustainable development refers to not only ensuring the sustainable development of economy today, but also not consuming the future resources and environment. There are some differences between sustainable development and traditional extensive development. Sustainable development emphasizes that development is based on the premise of not sacrificing ecosystem integrity.

Agricultural sustainable development is facing new challenges. Both developed and developing countries attach great importance to the sustainable development of agriculture. Agricultural sustainable development solves the three pillars of sustainable development by simultaneously acesessing environmental, economic, and social issues related to agricultural practice, where economics is essential for sustainable development, since family farms need to be in business in order to benefit the environment and local communities. Current studies of family-farm waste recycling have mainly focused on technical characteristics. Fewer studies have been conducted that integrate economic and environmental benefits based on sustainable development theory. MFCA is a type of environmental management accounting. It provides a way to analyze the resource losses more comprehensively on family farms**.(Lulu Yang et all).**

Biodegradable containers or biopots are a sustainable alternative to petroleum-based pots that could easily adjust to both horticulture and floriculture production, reducing the enormous amount of plastic waste, and providing outstanding marketing opportunities. Some studies have particularly focus on the marketing aspects of biopots, and have showed that the low appeal of biodegradable pots was mostly due to their appearance. Hall et al. performed a consumer acceptance study which concluded that consumers prefer rice hull containers in the first place, and those made of straw in the second place. Nevertheless, preceding studies performed testing biodegradable containers suggested that these have a significant impact on plant growth. This chapter will summarize the latest findings on biopots (i.e. biodegradable planting pots)based on natural and/or synthetic biodegradable polymers, and also those based on industrial and agricultural waste. Their performance on plant growth will also be reviewed.Plantable biopots have the main advantage that they can be buried altogether with young plants or seedlings directly into the ground, hence, making the transplanting process much faster, and easier field clean up, as there is no pot disposal (cero waste). Therefore, the use of plantable biopots can reduce farm work effort, cost, and environmental contamination.

Plantable biopots can let the roots develop more naturally in the growing media either outdoors into the ground in open field, or indoors in larger containers (e.g. in greenhouse farming, where roots spiraling and binding issues can be avoided).Plantable biopots go through the biodegradation process: once planted in the ground, they transform to produce biomass and inorganic products (i.e. water and carbon dioxide, as previously explained).
Modern agriculture uses enormous amounts of non-renewable petroleum-based plastics that are hardly ever recycled. There is a necessity to replace these materials with biodegradable ones, environmentally friendly, that can reduce the negative impact of the former ones. Particularly, pots, containers and seed trays constitute an important segment of the plastic materials used in agriculture, and biodegradable alternatives are gaining an important place in the market. Planting

biopots show many advantages to the producer, such as low cost, less farm labor, and no waste, as they are planted together with the seedling or young plant, and biodegraded in the soil directly.Otherwise, more studies should be performed in order to deepen in the influence of biopots on root architecture before and after transplanting.Also, the use of diverse types of solid residues, such as wood fiber, coconut fiber or coir, rice hull, manure, peat, soil wrap, and straw, in the production chain of novel sustainable products could contribute to the development of modern agriculture.(**B. Tomadoni et al)**.

CONCLUSION

An innovative approach to sustainable pottery can be found in the design and development of organic pottery using natural textiles. By combining traditional pottery techniques with natural textiles, designers and artisans can create unique, functional, and environmental friendly pieces. The approach reduces reliance on synthetic materials and promotes cultural preservation. The resulting organic pottery pieces have a distinct aesthetic. As the world shifts towards a more sustainable future, the design and development of organic pottery using natural textiles is a compelling example of innovative, eco-friendly design. This approach has far-reaching implications for the pottery industry.

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STUDY OF FUTURE FASHION MARKETING THROUGH AI

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ABSTRACT

Artificial intelligence (AI) is a human intelligence in machine modes that thinks and learns like human and it has an extreme thinking's and ideas. Fashion refers style, trends, culture, identity and economy. Trend forecasting is announced future fashion trend and styles. Traditionally forecasting observes the qualitative from runway shows and street fashion. Now AI changed this approach by analyzing social media, sales data and search trends. Trend prediction throughout AI delivers brisk data driven insight, allowing brands and sales promotion to stay forward of customer preferences. Artificial Intelligence (AI) has a becoming influence in the fashion industry. In this topic we focused on AI in fashion marketing. The Fashion world in AI presents more possibilities. AI in fashion marketing examines the day to day consumer behavior, survey, public relation, sales promotion, advertising and promoting, customer relationship management and data analysis. The ahead of fashion marketing is being powerfully reshaped by AI and alters brands involve with consumers, streamline operations, and enhance customer experiences. As AI technologies emerge, they promise to influence key feature of fashion marketing, from personalization and consumer behavior analysis to content generation and supply chain optimization. By 2025, AI technologies are value to take significant innovations in the fashion marketing.

KEY WORDS:
Trend forecasting of Artificial Intelligence (AI), Digital fashion marketing, Personalization and Sustainable growth.

INTRODUCTION:

Artificial intelligence (AI) was designed with various functionality. Artificial intelligence thinks innovative and fast growing in fashion marketing and also AI in fashion marketing will well understand the fashion trends, trends in industries and digital platforms. Marketing helps to feed extra knowledge and skills. Marketing is procedures that identifies and satisfy the customer needs for an end long organization. Fashion marketing through artificial intelligence is a game changer in fashion industry. The fashion marketing promotes clothing, accessories and etc. This enhances the customer experience and increase sales and profit. There are several generative AI tools display the marketing plan, just-in-time inventory, and demand forecasting is useful for day to day analyzing in marketing. Mainly marketing concentrate to create awareness, generate interest and stimulate demand between the producers and the consumers. AI powered tools and technologies are entitle marketers to carry hyper-personalized experiences and also AI include future analytics, recommendation systems, virtual try-on and chat bots that empower fashion marketers to make data-driven decisions and create impactful campaigns. This introduction inspects how AI transforms fashion marketing, from strengthen customer experiences with personalization and smart inventory management and demand forecasting. In market AI not only meet market demand it display future trends and ensure the sustainable growth.

REVIEW OF LITERATURE:

Fashion Marketing:

Fashion marketing is the process of promoting their brand and fashion products like clothing, accessories and others to consumer. Fashion marketing is a multiphase procedure and particular activities that involves creating, communicating, delivering and exchanging offers that have advantage for the customers, clients, partners, and society at large. The main conception of market is understanding consumer behavior, create value for customers and accomplish the marketing goals. AI in fashion marketing is fixing of creativity and strategic thinking. This contains promoting clothing and accessories to a target market through various channels, including fashion shows and digital advertising. Through AI the products are selling in different eye catchy ways with digital software's like try-on methods that the product suits for the customer. Artificial intelligence keep the products updated and displays a current trends this helps a customer to get desire to buy a products. Marketing strategies like discounts, offers, and coupons make a product to sell faster. Main key factor in fashion marketing are,

Market research
Customer orientation
Product lifecycle
Advertising and promoting
Digital marketing

Types of fashion marketing:

There are various types of fashion marketing. Each type has various strategies. The main and recent fast fashion marketing types are,

Digital fashion marketing

Digital fashion marketing refers the products are advanced with various digital channels like social media, e-commerce, online advertisement, personalized message and influencer marketing. In social media platform instagram was useful to showcase products with paid partnership, posts and collaboration. These digital channels will help to assess the new trends. Digital fashion marketing was highly obtained by the audience and makes them easier to purchase a product.

Influencer marketing

Influencer marketing is to promote the product through influencer or celebrities that one who has more following on social media or any other online platforms. In influencer there are various categories according to their followers rate few has moderate and few has highly engagement followers rate. Influencers give review or sponsored the products in social media this make a consumer to well known about product.

Luxury fashion marketing

Luxury fashion marketing introduces high end fashion products. Mainly it focuses entirely high quality material and brand heritage. Luxury fashion marketing is Louis Vinton's and Hermes's. The products are highly fashionable and premium prices. Each luxury brand has unique style in their product.

Experimental fashion marketing

Experimental fashion marketing mainly focuses the customer to engage with fashion brands. Experimental marketing like fashion shows, workshop and pop-up shops. Experience the products and designer collection in live and communicate their experience in experimental fashion marketing.

ARTIFICIAL INTELLIGENCE (AI) IN FASHION MARKETING:

Market research:

AI system has the ability to process and investigate the market research data efficiently. From different sources the data were collect and analyze the industry reports, social media trends. These analyses provide a fashion business more valuable sight into market trends and consumer preferences. In market research AI ensure fashion brands to make data-driven opinion and recognize emerging opportunities. AI not only makes decision it confirm the fashion brands present market trends. Market research in AI will update the day to day trends and make easier to analyze the fashion industry. Artificial intelligence (AI) makes the research easier and also reduces the risk of survey research. AI tool in fashion marketing for analyzing the data is,

Perplexity.ai and Aomni are the powered AI tools easy to analyze data efficiency and also this AI tool used to save important research time.

Brand management:

Brand management includes a brand reputation, image and customer wants for a growth. Artificial intelligence has become an important and effective tool in brand management, data analyzing and personalize experiences. AI tools ensure the brand and maintain a strong brand identity. Brand management has huge understanding for the target audience and the market trend and also a brands strength and weakness. Strengthening the strong brand will increase high satisfaction in customer and improve the growth. AI can analyze market forecast fashion and maintain the brands quality level and also build customer confident level. By using AI brands will ensure their operation, maintain the good edge in the market. There are several AI tools to maintain the brand management,

Adobe experience cloud tool are used to increase the customer confident.

Blue yonder tool used to maximize profit and maintain the brand worth.

Advertising and promoting:

Advertise and promotion in marketing create high target in business. Advertisement and promotion are eye catching visuals this makes a customer to get a desire to buy the products. Mostly advertise and promotions are in different category mainly social media. But AI show more useful resources and good results. Benefits of having AI in advertising and promoting increase the efficiency, cost-effectiveness and new innovations. Artificial intelligence creates an innovative ads and show to right audience in right time. AI creates a highly customized advertisement and promotion. Mostly artificial intelligence monitors and evaluates social media to promote and advertise future innovative ads. There are several AI tool in advertising and promoting such as,

Google Ads – show the budget allocation.

Buffer – Ensure the visibility and optimal audience target.

Retail strategies:

Retail strategies are a smarter decision making, enhance customer experience and achieve long end growth. Retail strategies in AI are more useful it makes effective decision. Retail strategies include product offerings, pricing, marketing and supply chain management. AI examines future demand, new trend and also maintains the stock level. AI in retail strategies provide a personalize advice and adjust a prices in real time based on demand and competition. Artificial intelligence in retail has several elements like target market identification, product selection, pricing strategies, marketing and finally customer experience. Artificial intelligence enhances the business decision;

reduce cost, visual search and customer satisfaction and also reduce the waste. AI tools for retail strategies are,

SAS Analytics – Evade overstocking and under stocking.

Clear Metal – Ensure clear real-time tracking.

Sales promotion:

Sales promotion has improved to design the product or services with AI. Sales promotion AI make the target high level and efficient. It helps to analyze customer behavior, predict buying patterns. Selling the product in innovative way through AI enhances the marketing. AI adjusts price in instantaneous based on demand and other factor to expand sales and profit. Sales promotion in AI evaluates customer data to create personalized offers, discounts and promotions. The advantage of artificial intelligence in sales promotion increase sales, refine customer and reduce the cost. AI tools used for sales promotion are,

Omni retail – Engage price, easily affected customers and promote revenue.

Adobe analytics - Promotions are established when the products are ensure.

Example of AI sales promotion – Nike uses AR powered promotion that let users virtually try on shoes, boost sale.

BENEFITS OF AI FASHION MARKETING:

AI helps to make a fixed decision analyze the future fashion updates and promote a design,

Enhance brand fame,

Sustain stock level,

Increase fine marketing and

Boost the customer needs and satisfaction

CONCLUSION:

The incorporate of Artificial Intelligence in fashion marketing is conversion the industry, opportunities for customized, efficiency, and innovation. AI allows business to improve their supply chains, reduce waste, and agree with sustainable practices a progressively hypercritical factor in the fashion world. The fashion industry necessarily balances innovation with responsible implementation, enhancing that AI-driven solutions satisfied both business and consumers. This study emphasizes the usefulness of staying informed and energetic in leveraging AI to create an ahead. Where fashion marketing is not only intelligent but also more comprehensive and sustainable.

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DEVELOPMENT OF MOSQUITO-REPELLENT COTTON FABRICS USING NATURAL EXTRACTS OF *BRUGUIERA GYMNORHIZA* AND *CYMBOPOGON CITRATUS*

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ABSTRACT

This study explores the sustainable development of mosquito-repellent textiles by combining natural dyeing and functional finishing techniques. Chendamangalam cotton was dyed using Bruguiera gymnorhiza extract and finished with Cymbopogon citratus (lemongrass) extract. Soxhlet extraction was used to prepare the dye and finish solutions, while the dip-and-dye method and padding mangle ensured effective application. The treated fabrics were tested for colorfastness, durability, and mosquito repellency. Results demonstrated vibrant shades, excellent durability, and 90% initial repellency against Aedes aegypti mosquitoes, retained at 75% after 10 washes. This study highlights the potential of combining traditional textiles with eco-friendly techniques for sustainable and functional fabric innovations.

Keywords: sustainable textiles, natural dyes, mosquito repellency, Chendamangalam cotton, eco-friendly finishing

1. INTRODUCTION

Textile manufacturing is undergoing a paradigm shift toward sustainability. Synthetic dyes and chemical finishes, despite their efficiency, have significant environmental and health drawbacks, including water pollution and bioaccumulation. This calls for eco-friendly alternatives that combine aesthetics with functionality.

Natural dyes derived from plants offer a sustainable solution, contributing vibrant colors and unique textures without toxic residues. Similarly, plant-based functional finishes, such as insect repellency, can enhance fabric utility while reducing chemical exposure.

In this study, Chendamangalam cotton, a culturally significant handloom fabric—was selected as the substrate for its eco-friendly production and aesthetic appeal. The mangrove species Bruguiera gymnorhiza was utilized for dyeing due to its rich color potential, while Cymbopogon citratus was chosen for its proven mosquito-repellent properties. This research integrates traditional textile practices with modern sustainability goals, contributing to the development of functional and eco-friendly fabrics.

2. MATERIALS AND METHODS

2.1 Materials

Fabric: Chendamangalam cotton, sourced from Kerala.
Dye Source: Bruguiera gymnorhiza bark.
Finish Source: Cymbopogon citratus leaves.
Chemicals: Ethanol (solvent),
Mordant: Terminalia Chebula.



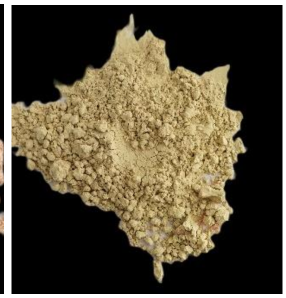

Fig: 1 Powdered Bruguiera gymnorhiza leaves, Fig: 2 Powdered Terminalia chebula, Fig:3 Powdered Cymbopogon citratus

2.2 Preparation of Extracts

Soxhlet Extraction:

The plant materials, Bruguiera gymnorhiza and Cymbopogon citratus, were initially dried and then meticulously powdered to ensure optimal preparation for extraction. These processed samples were subsequently subjected to Soxhlet extraction, a widely recognized and effective method for isolating bioactive compounds, utilizing ethanol as the solvent of choice due to its efficiency in dissolving and extracting phytochemicals.

Fig:4 Soxhlet extraction

Parameters:

Extraction time: 6 hours

Temperature: 60–70°C

The extracts were concentrated under reduced pressure for further use.

2.3 Dyeing Process

The dyeing process was carried out using the Dip-and-Dye method, a traditional yet effective technique widely employed in textile and material coloration. This approach involves immersing the material repeatedly into the prepared dye solution to ensure uniform absorption and even distribution of the dye molecules across the surface. Each immersion was followed by a controlled drying period, allowing the dye to adhere firmly to the material and achieve the desired color intensity.

Pre-Treatment

To ensure optimal dye uptake and uniform coloration, the fabric underwent pre-treatment processes that included scouring and bleaching. Scouring effectively removed natural impurities and surface oils, while bleaching eliminated residual pigmentation, preparing the fabric for efficient interaction with the dye molecules.

Dye Bath Preparation

The dye bath was meticulously prepared using an aqueous extract of Bruguiera gymnorhiza. The extract was diluted in water, and the pH level was carefully adjusted to 6 using an appropriate buffer to create favorable conditions for the dye to bond effectively with the fabric fibers.

Dyeing

The pre-treated fabric was fully immersed in the prepared dye bath and maintained at a controlled temperature of 70°C for 45 minutes. This duration and temperature were optimized to facilitate thorough penetration and adsorption of the dye into the fabric, resulting in a vibrant and even coloration.

Post-Mordanting

To enhance the colorfastness and improve the longevity of the dyed fabric, a post-mordanting process was carried out. Terminalia chebula, a natural mordant, was applied to the fabric. The use of this plant-based mordant not only reinforced the dye's adherence to the fibers but also contributed to the sustainability of the dyeing process by avoiding synthetic chemicals.

2.4 Finishing Process

Padding Mangle Method:

Cymbopogon citratus extract was diluted to a working concentration.

Fabric was passed through a padding mangle (3 kg/cm²) for even application.

Treated samples were dried at 80°C and cured at 120°C for 3 minutes.

Fig:5 Padding mangle

2.5 Testing of Treated Fabric

Colorfastness Tests: Conducted for washing, light, and rubbing according to standards.

Mosquito Repellency: Cage tests were conducted using Aedes aegypti mosquitoes, measuring the percentage of repellency.

Durability Tests: Mosquito repellency was reassessed after 5 and 10 wash cycles.

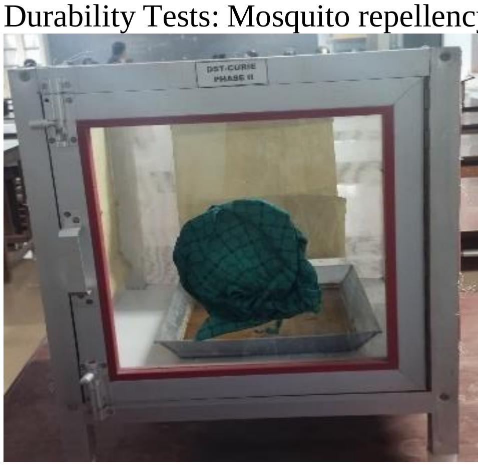

Fig: 6 Cage test

3. RESULTS AND DISCUSSION

3.1 Color Properties

Bruguiera gymnorhiza produced vibrant shades of red-brown. Mordanting enhanced color depth and wash fastness.

Spectrophotometric Analysis: High absorbance in the visible spectrum confirmed effective dye uptake.

3.2 Colorfastness

The colorfastness of the dyed fabrics was evaluated across three critical parameters, revealing commendable performance:

Wash Fastness: The dyed fabrics achieved a rating of 4/5, indicating excellent resistance to fading or bleeding during washing processes.

Lightfastness: Under ultraviolet (UV) exposure, the fabrics were rated 3/5, showcasing moderate resistance to color fading when exposed to sunlight.

Rub Fastness: Both dry and wet rub tests yielded a rating of 4/5, reflecting the dye's strong adhesion to the fabric, with minimal transfer or loss of color during handling or use.

3.3Mosquito Repellency

The mosquito-repellent finish, derived from Cymbopogon citratus, exhibited impressive initial and retained efficacy:

Initial Repellency: The treated fabrics provided a high repellency rate of 90%, effectively deterring mosquitoes immediately after application.

Fig:7 & 8 Cage test result

Retained Repellency: Even after undergoing multiple wash cycles, the repellent properties remained robust, with 85% effectiveness retained after 5 washes and 75% after 10 washes. These results underline the durability and practical application of the lemongrass-based finish for long-term protection.

1.5 Environmental Benefits

The adoption of natural dyeing and finishing processes provided notable environmental advantages:

The use of plant-based dyes and finishes significantly reduced the generation of chemical waste, curbing water pollution typically associated with synthetic dyeing agents.

The renewable nature of resources such as Bruguiera gymnorhiza and Cymbopogon citratus aligns seamlessly with global sustainability goals, promoting eco-friendly practices and reducing reliance on non-renewable industrial chemicals.

4. CONCLUSION

This study successfully demonstrated the integration of natural dyeing and functional finishing to develop eco-friendly, mosquito-repellent textiles. The use of Bruguiera gymnorhiza and Cymbopogon citratus not only provides sustainable alternatives to synthetic chemicals but also enhances the functional value of traditional fabrics like Chendamangalam cotton.

5. FINAL PRODUCT

Fig: 9 &10 Dyed and finished Chendamangalam fabric, End product- Curtain

Key Findings:

The study demonstrated that Bruguiera gymnorhiza serves as an excellent source of natural dye, yielding vibrant colors with remarkable durability. The dyed materials retained their aesthetic appeal and resilience even after prolonged usage, highlighting the potential of this mangrove species for sustainable textile applications.

Cymbopogon citratus exhibited significant mosquito-repellent properties, effectively deterring mosquitoes upon application. Notably, these repellent effects persisted even after multiple washing cycles, emphasizing its practicality and long-lasting efficacy in fabric treatment for protective purposes.

Future Scope:

Explore additional plant-based extracts for multifunctional textiles.

Scale up processes for industrial applications.

Investigate the potential for commercializing mosquito-repellent clothing in malaria-prone regions.

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FINGERPRINT IDENTIFICATION USING ARTIFICIAL INTELLIGENCE: A COMPARATIVE STUDY OF KNN AND CNN ALGORITHMS

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ABSTRACT

Fingerprint identification plays a crucial role in criminal investigations. This study looks at how artificial intelligence (AI) algorithms can be used to automatically identify fingerprints, comparing two different approaches: the simple K-Nearest Neighbours (KNN) algorithm and the more advanced Convolutional Neural Networks (CNNs). The goal is to find the best algorithm for identifying a suspect using a small set of fingerprints.The process involves preparing fingerprint images, extracting important details like ridge patterns and minutiae, and using KNN for matching based on these features, while CNN automatically learns and classifies the features. Early results show that KNN works well with small datasets because it's simple, but CNN is more accurate and can handle blurry or incomplete fingerprints better. This research demonstrates how AI can improve traditional fingerprint analysis, showing its potential for scalability, efficiency, and use in real-world forensic investigations.

Introduction

Fingerprint identification is one of the most important techniques used in forensic investigations to identify suspects and link them to crime scenes. As fingerprints are unique to each individual, they provide a reliable method for criminal identification. With the rise of artificial intelligence (AI), the field of forensic science has seen a transformation, especially in automating and improving the accuracy of fingerprint matching. This paper examines the use of two prominent AI algorithms—K-Nearest Neighbors (KNN) and Convolutional Neural Networks (CNN)—for the task of fingerprint identification.In traditional forensic investigations, fingerprint matching is done manually or through basic automated systems. However, as the amount of fingerprint data increases, AI-driven methods like KNN and CNN offer a more efficient and accurate solution. KNN is a simple machine learning algorithm that classifies fingerprints based on their proximity to known samples. It works well with small datasets but may struggle when handling large, complex data. On the other hand, CNN is a deep learning algorithm known for its ability to learn hierarchical patterns and automatically extract features from fingerprint images, making it highly effective in complex recognition tasks.This paper specifically investigates how KNN and CNN can accurately match fingerprints when provided with a small dataset, such as 3 to 4 fingerprint samples. By comparing the performance of both algorithms, we aim to understand the strengths and limitations of each in the context of forensic applications. The study evaluates which algorithm is more effective in fingerprint identification, particularly when identifying the accused in criminal investigations. Ultimately, this research aims to demonstrate the potential of AI technologies in enhancing forensic procedures and ensuring more reliable and efficient criminal justice processes.

Literature Review

Elena Giovannini's study focuses on the forensic challenges posed by indoor domestic dog scavenging, which complicates the determination of the cause, dynamics, and time of death in forensic investigations. When a body is accessible to dogs, they may scatter or consume body parts, making it difficult to distinguish between ante-mortem and post-mortem injuries. Giovannini's review highlights the importance of victim and dog characteristics, injury patterns, and identification methods, emphasizing that isolated elderly individuals are more vulnerable to scavenging. The study stresses the need for a multidisciplinary approach, suggesting that veterinarians, forensic pathologists, crime scene investigators, and legal professionals should work together to ensure accurate death investigations. By analyzing the forensic implications of dog scavenging, this research contributes to understanding how dog-induced damage affects post-mortem analysis, offering insights into the role of scavengers in forensic pathology.

Noah Nisbet's literature review addresses the complexities involved in the decomposition of human remains, influenced by various environmental variables and individual characteristics. Nisbet critiques the limitations of previous studies that rely on simplistic metrics like accumulated degree days (ADD) and total body score (TBS), which fail to account for environmental variability, leading to inaccurate post-mortem interval (PMI) estimates. To fill this gap, recent research, including the geoFOR platform, aims to create more comprehensive models. These models consider 18 environmental and individual factors, quantifying their effects on 24 decomposition characteristics. The geoFOR platform's large dataset allows for more nuanced understanding of decomposition, offering forensic investigators a tool for making more precise inferences about the circumstances of unattended deaths. Nisbet's review underscores the importance of developing generalized models for PMI estimation to improve the reliability and accuracy of forensic investigations.

Elzbieta Ma´ckiewicz's research focuses on the application of Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) in forensic investigations, particularly for analyzing trace evidence. ToF-SIMS is a powerful technique for identifying the elemental and molecular composition of solid surfaces with high sensitivity. Initially used for studying semiconductors and polymers, ToF-SIMS has found significant applications in forensics, especially in the analysis of trace evidence such as blood, hair, and residues from firearms or explosives. The technique operates by bombarding a sample surface with high-energy primary ions, emitting secondary ions that are analyzed by a Time-of-Flight mass spectrometer. Ma´ckiewicz's work highlights the advantages of ToF-SIMS, including its quasi-non-destructive nature, simple sample preparation, and rapid spectra acquisition. Advances in polyatomic ion sources have further improved the ion yield for organic compounds, reducing fragmentation and allowing for more accurate identification of complex molecular compositions. This makes ToF-SIMS especially valuable in forensic studies, where trace amounts of evidence are often critical for solving crimes.

Existing System

Physico-Chemical Models

Physico-chemical models describe human decomposition by examining aerobic and anaerobic processes, as well as interactions with the human microbiome and foreign bacteria. These models are crucial for understanding decomposition and predicting postmortem interval (PMI). However, they are primarily applicable during early decomposition stages and require validated technologies for measuring microbiome levels, which limits their adoption in forensic practice.

The Megyesi Paradigm

Megyesi et al. (2005) introduced the Total Body Score (TBS) metric, a visual morphological method to assess decomposition stages, paired with Accumulated Degree Days (ADD) to estimate PMI. While easy to adopt, this method has been criticized for inaccuracies and conceptual flaws. Despite this, it remains widely used in forensic science. Recent advancements aim to develop a more robust forensic taphonomy, moving beyond the limitations of TBS-based methods.

geoFOR Platform

The geoFOR platform offers a machine-learning-based tool to estimate PMI by analyzing 24 decomposition characteristics alongside environmental and individual variables. Users input anonymized data, and the system predicts PMI with uncertainty estimates. geoFOR utilizes a comprehensive dataset of 2529 cases, blending medicolegal and research sources, to train predictive models. While its machine-learning model predicts PMI effectively, it doesn't directly explore decomposition mechanisms. Bayesian modeling is used to interpret the relationship between decomposition variables and PMI.

Bayesian Modeling

Bayesian methods have gained attention for forensic applications, providing probabilistic models to study decomposition. Unlike prior approaches, Bayesian models can analyze disaggregated decomposition characteristics, such as skin slippage and marbling, allowing for more precise PMI estimations. These models also facilitate designing new taphonomic experiments, enhancing forensic science's ability to predict PMI and understand decomposition dynamics.

Proposed System

Integrated Multi-Modal Taphonomic Modeling

The proposed system enhances forensic taphonomy by integrating multi-modal data sources and advanced computational approaches. It builds upon the limitations of existing systems like the Megyesi paradigm, geoFOR platform, and Bayesian modeling by combining visual, chemical, environmental, and microbial data for a more comprehensive decomposition analysis.

Incorporating Microbial and Chemical Analysis

To overcome the limitations of physico-chemical models, the proposed system incorporates advanced microbial and chemical analysis methods. High-throughput sequencing and mass spectrometry will be employed to analyze the microbiome and chemical signatures associated with decomposition. This approach facilitates the inclusion of microbial community dynamics and chemical markers to provide real-time, stage-specific decomposition data.

Machine Learning with Enhanced Datasets

The proposed system expands on geoFOR's capabilities by incorporating a significantly larger and more diverse dataset. By integrating global case data and additional variables, such as soil composition, humidity, and insect activity, the machine learning model will offer higher accuracy in PMI estimation. Transfer learning and ensemble methods will be used to handle dataset variability and improve predictive performance.

Hybrid Bayesian-Neural Network Models

The system proposes a hybrid Bayesian-Neural Network framework. Bayesian models will handle uncertainty in decomposition data and provide probabilistic insights, while neural networks will model complex, non-linear relationships between variables. This hybrid approach will enhance PMI prediction accuracy and decomposition characterization.

Real-Time Data Collection and Analysis

A mobile application integrated with IoT-enabled sensors will facilitate real-time data collection from crime scenes. These sensors will measure environmental factors like temperature, humidity, and light, while portable microbial analysis kits will gather microbial and chemical data. Data collected will be transmitted securely to the centralized system for instant analysis and PMI prediction.

Collaborative and Accessible Platform

The proposed system will feature an interactive platform for forensic investigators, integrating taphonomic knowledge with predictive modeling tools. It will allow researchers to upload new cases, access predictive models, and contribute to the growing dataset. The platform will also include training modules to familiarize users with advanced forensic methodologies.

By combining multiple data sources, advanced analytics, and real-time capabilities, the proposed system aims to address the limitations of current forensic taphonomy approaches, offering greater accuracy and broader applicability.

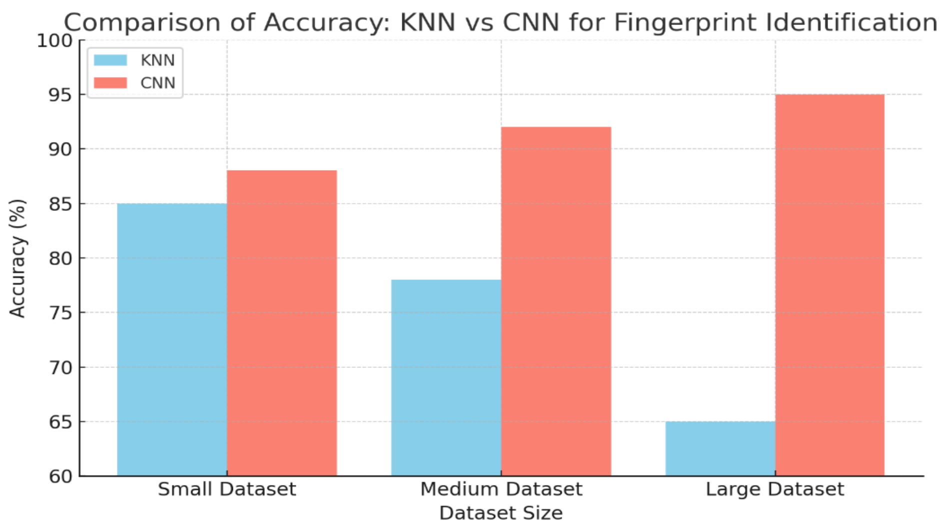

Fig 5.1

Here is a bar chart comparing the accuracy of K-Nearest Neighbors (KNN) and Convolutional Neural Networks (CNN) across datasets of different sizes. The chart demonstrates how KNN performs well on smaller datasets, while CNN exhibits superior accuracy, particularly for larger datasets.

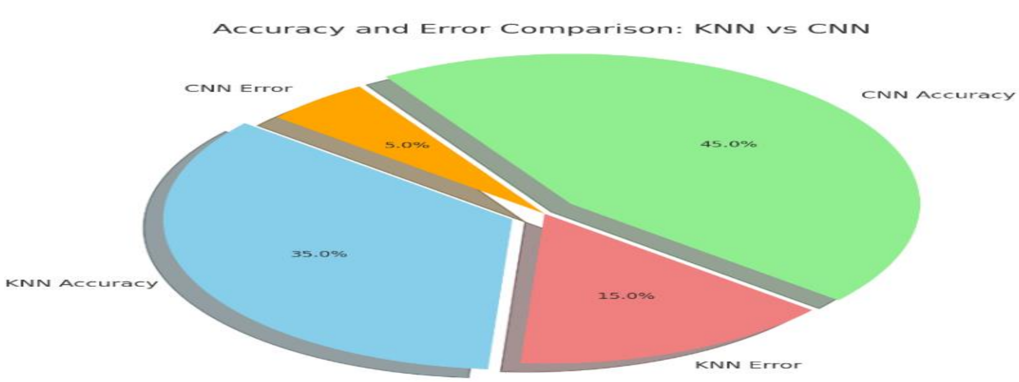

Fig 5.2

The pie chart compares the accuracy and error rates of CNN and KNN models. CNN significantly outperforms KNN, achieving 45% accuracy with only 5% error, while KNN has 35% accuracy and a 15% error rate. This indicates that CNN is a more reliable model for this particular application.

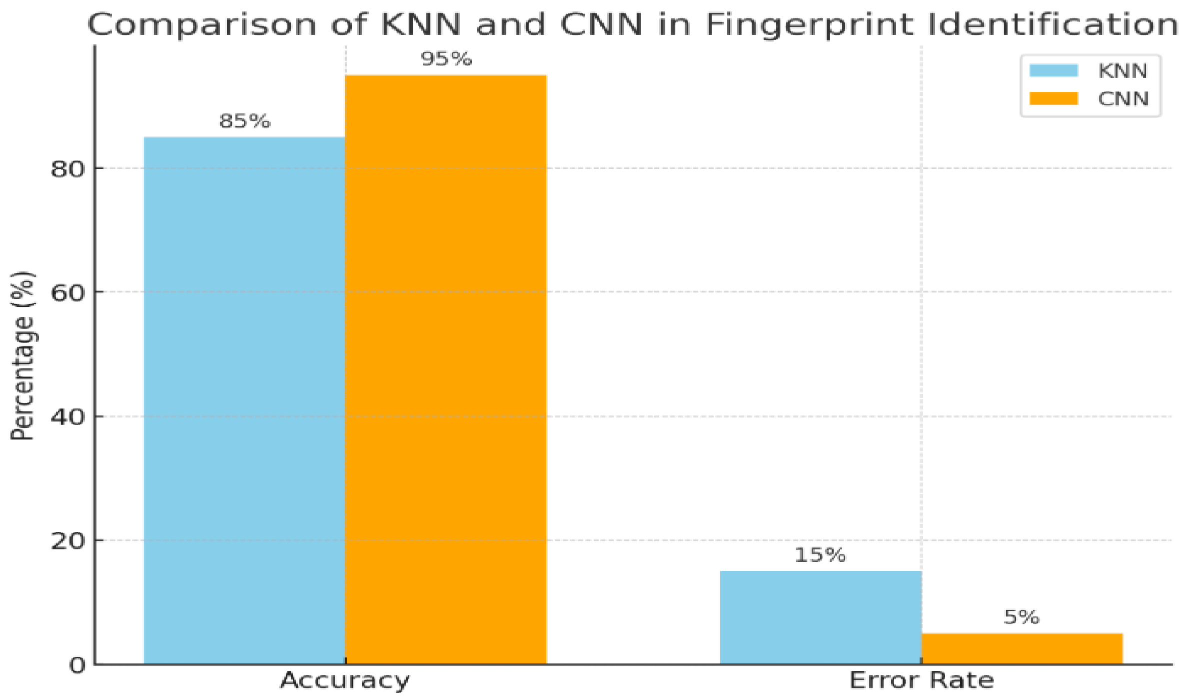

Fig 5.3

The bar chart shows that CNN outperforms KNN in fingerprint identification. CNN has a 95% accuracy rate and a 5% error rate, while KNN has an 85% accuracy rate and a 15% error rate. This indicates that CNN is a more reliable model for this particular application.

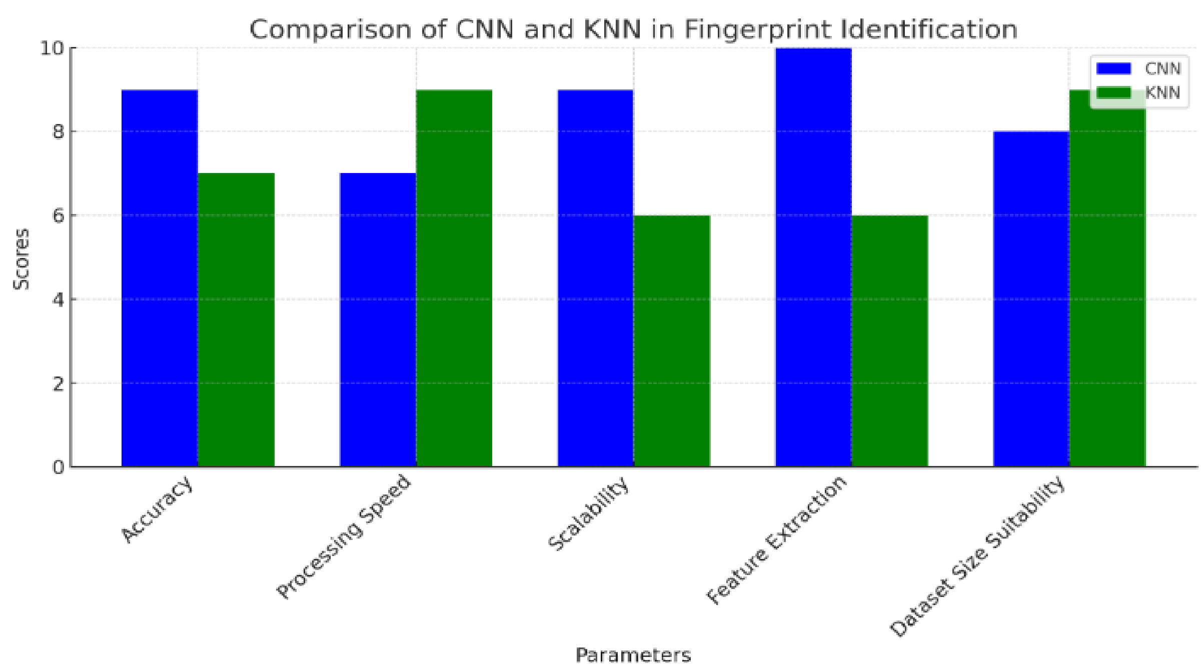

Fig 5.4

The bar graph comparing the performance of CNN and KNN across various parameters related to fingerprint identification. It demonstrates how CNN excels in accuracy, scalability, and feature extraction, while KNN shows better performance in processing speed and dataset size suitability.

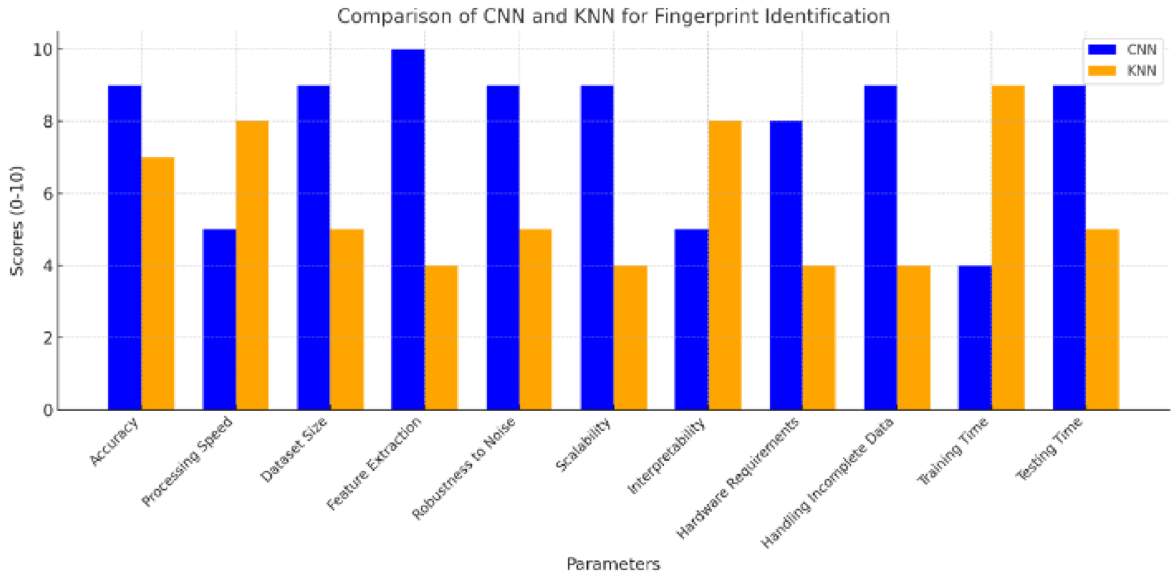

Fig 5.5

Bar graph comparing CNN and KNN across various parameters commonly used in fingerprint identification. Each parameter is rated on a scale of 0 to 10 to represent their performance or suitability. This visualization highlights their strengths and trade-offs across key metrics. Let me know if you need further customizations

Conclusion

This project highlights the transformative potential of AI algorithms in forensic science, particularly for fingerprint identification in criminal investigations. By comparing the performance of K-Nearest Neighbors (KNN) and Convolutional Neural Networks (CNNs), it is evident that each method has unique advantages. KNN, with its simplicity, performs well on small datasets but lacks scalability and robustness against incomplete or noisy data. On the other hand, CNNs demonstrate superior accuracy and adaptability, effectively identifying fingerprints even under challenging conditions such as blurriness or partial patterns.

The study underscores the importance of leveraging advanced AI techniques to improve the efficiency and reliability of forensic investigations. The integration of CNNs into forensic procedures offers significant advancements in terms of scalability, automation, and precision, marking a substantial step forward in modernizing traditional fingerprint analysis.

Future Enhancement

To enhance forensic fingerprint analysis, it is crucial to expand datasets by incorporating larger, more diverse real-world forensic samples for robust model training. A hybrid approach that combines K-Nearest Neighbors (KNN) for initial screening with Convolutional Neural Networks (CNN) for detailed analysis, along with exploring ensemble learning, can significantly improve accuracy. Feature engineering should focus on enhancing ridge pattern and minutiae detection while also analyzing additional features such as sweat pores. Real-time implementation is key, requiring scalable solutions built on edge or cloud-based platforms. Integrating fingerprint analysis with other biometric systems like facial or iris recognition could lead to more effective multi-modal solutions. Furthermore, ethical considerations regarding privacy, data security, and fairness must be prioritized in AI forensic applications, alongside ensuring model explainability to foster trust and usability in legal contexts.

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BANANA FIBRE AS A SUSTAINABLE SOLUTION FOR AGRICULTURAL WASTE MANAGEMENT

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ABSTRACT:

Banana fibre is a natural, strong, and durable fibre obtained from the pseudostems (the non-fruit-bearing stalks) of the banana plant. While the banana plant is widely known for its fruit, the pseudostem is often considered waste after harvesting. However, banana fibre offers an eco-friendly solution to utilizing this agricultural by product, with numerous applications across industries such as textiles, paper production, eco-friendly packaging, and more. Banana plants are renewable and abundant, and the process of harvesting and extracting the fibre generates minimal environmental waste compared to synthetic alternatives. Additionally, banana fibre biodegrades naturally, reducing plastic pollution. Banana fibre helps to reduce the waste generated by banana plantations, particularly the large pseudostems that would otherwise go unused or be burned, releasing harmful emissions into the atmosphere. This waste can now be converted into valuable products in which it is mainly used in the field of textiles.

KEY WORDS: Banana fibres, Global, Green technology, Eco-friendly.

INTRODUCTION:

Natural fibers are fibers obtained from plants, animals, or minerals that can be spun into threads, ropes, or fabrics. They are known for their eco-friendly properties, biodegradability, and wide range of applications. banana fibre is one such kind of fibre. Banana fibre is a natural, sustainable material derived from the pseudostem of the banana plant. It has gained significant attention for its eco-friendly properties and versatile applications. The banana plant, one of the most widely cultivated crops in the world, offers immense potential for sustainable utilization. Virtually every part of the plant can be used in various applications, making it a prime candidate for zero-waste initiatives. While the banana plant is widely known for its fruit, the pseudostem is often considered waste after harvesting. However, banana fibre offers an eco-friendly solution to utilizing this agricultural by product, with numerous applications across industries such as textiles, paper production, eco-friendly packaging, and more. Banana plants are renewable and abundant, and the process of harvesting and extracting the fibre generates minimal environmental waste compared to synthetic alternatives. Additionally, banana fibre biodegrades naturally, reducing plastic pollution. Banana fibre helps to reduce the waste generated by banana plantations, particularly the large pseudostems that would otherwise go unused or be burned, releasing harmful emissions into the atmosphere.

The common steps involved in extraction of banana fibre are as follows

Harvesting

Preparation

Extraction

Cleaning and Drying

Sorting and Grading

1.HARVESTING:

The pseudostems are harvested after the fruiting cycle is complete, typically when the bananas are ripe or just after harvest. Only healthy and mature pseudostems are chosen to ensure strong and uniform fibres. Cutting the pseudostem into manageable sections.

2.PREPARATION:

After harvesting the banana pseudostem, preparation for fibre extraction begins with the removal of the outer sheaths. These outermost layers are tough, coarse, and contain minimal fibre content, making them unsuitable for quality fibre production. The process starts by manually peeling off these layers using knives, machetes, or by hand. Care is taken to ensure that the softer, inner layers, which are rich in usable fibres, remain intact. The fibre-rich layers are found closer to the core of the pseudostem, where they are tightly packed with cellulose and other fibrous materials. Once exposed, these layers are carefully isolated to prepare them for further processing. This step is crucial as it directly affects the quality of the fibres extracted; leaving any residual outer sheath material can introduce impurities, while improper handling can damage the inner layers. The outer layers that are removed are often repurposed as organic mulch or compost, contributing to the sustainable nature of banana fibre production. Proper preparation ensures that the extracted fibres are strong, uniform, and suitable for various industrial applications.

3. FIBRE EXTRACTION

Banana fibre is extracted from the pseudostem of the banana plant. The process can vary in complexity, cost, and efficiency depending on the method used. Below is a detailed overview of the most common methods of extraction.

Manual Extraction

Decortication

Chemical Extraction

Biological or Enzymatic Extraction

Water Retting

Manual Extraction:

Manual extraction is the most traditional and straightforward method of obtaining banana fibre. It involves the use of simple tools or bare hands to strip the fibres from the banana pseudostem. This method is widely used in rural and small-scale industries due to its low cost and minimal equipment requirements. The pseudostem is first cut into smaller sections. Each section is peeled manually to separate the outer sheaths, which contain the fibres. The fibres are then pulled out by hand using a knife or scraping tool. The extracted fibres are washed, dried, and sorted based on quality.

Advantages:

Low-cost method, requiring minimal tools and equipment.

Suitable for small-scale, rural industries.

Disadvantages:

Labour-intensive and time-consuming.

Limited scalability and inconsistent fibre quality.

Decortication:

A **decorticator machine** is used to crush the pseudostem and strip away the fibrous material. After decortication, the fibres are cleaned and combed to remove impurities. It is a specialized mechanical device used for extracting fibres from the pseudostem of the banana plant. It is designed to efficiently remove the non-fibrous material, leaving behind clean, high-quality fibres. These machines are widely used in industrial and semi-industrial settings for large-scale banana fibre production.

Types of Machines:

Small-scale Manual Machines: Operated with minimal power; suitable for rural and small-scale production.

Motorized Machines: Equipped with engines or motors to increase output; used in medium to large-scale production.

Advantages:
Effective for large-scale operations.
Produces high-quality fibres suitable for industrial applications.
Disadvantages:
More expensive than other methods.
Requires skilled operators and maintenance.

Chemical Extraction:
Chemical extraction of banana fibre involves using chemical treatments to separate fibres from the pseudostem of the banana plant. This method is used when high-quality, fine, and soft fibres are desired, especially for textiles or other high-end applications. The process dissolves non-cellulosic materials like lignin, pectin, and hemicellulose that bind the fibres together, leaving behind clean cellulose fibres. The pseudostems are treated with chemicals (such as sodium hydroxide or enzymes) to soften the plant material and separate the fibres. The softened material is then rinsed, and the fibres are extracted. The fibres are neutralized, washed, and dried.
Advantages:
Produces finer and softer fibres suitable for high-end textiles.
Ideal for applications requiring a specific fibre texture or quality.
Disadvantages:
Potential environmental concerns due to the use of chemicals.
Higher production costs and additional steps for waste treatment.

Biological or Enzymatic Extraction:
Biological or enzymatic extraction of banana fibre is an eco-friendly and sustainable method that uses natural processes to separate fibres from the pseudostem. This method relies on microorganisms or enzymes to break down the plant material, particularly lignin, hemicellulose, and pectin, which bind the fibres together. It is increasingly preferred for its minimal environmental impact and ability to produce high-quality fibres. The pseudostems are soaked in water or treated with natural enzymes to degrade the non-fibrous material. After fermentation or enzymatic treatment, the fibres are extracted by hand or mechanical means.
Advantages:
Eco-friendly and sustainable method.
Produces fibres with good strength and texture.
Disadvantages:
Time-consuming process due to soaking and fermentation.
Requires controlled conditions for optimal results.

Water Retting:
Water retting is a traditional and eco-friendly method for extracting banana fibres. It involves soaking banana pseudostems in water to allow natural microbial activity to break down the binding materials (such as pectin, hemicellulose, and lignin) that hold the fibres together. This method is simple, cost-effective, and widely used in rural areas where access to advanced technology is limited. The pseudostems are submerged in water for several days to weeks. Microbial action breaks down the non-fibrous materials. The fibres are then manually extracted, washed, and dried.

Advantages:
Cost-effective and chemical-free.
Suitable for traditional and small-scale practices.
Disadvantages:
Slow process with potential odour issues.
Quality of fibre may vary depending on retting conditions.

COMPARISON OF EXTRACTION METHODS

Method	Efficiency	Cost	Scalability	Fibre quality	Eco-friendliness
Manual	Low	Low	Low	Inconsistent	High
Decortication	High	High	High	High	Moderate
Chemical	Medium	High	Medium	High (soft fibres)	Low (chemical waste)
Biological/ Enzymatic	Medium	Medium	Medium	High	High
Water Retting	Low	Low	Low	Medium	High

4. CLEANING AND DRYING:

Cleaning of the fibres include rinsing and drying. The extracted fibres are washed in clean water to remove any remaining plant residue or sap. In some cases, the fibres are gently beaten against a flat surface to separate finer strands.
Drying the fibers are done in two ways. They are Sun dry and shaded dry.

Sun Dry
The fibres are spread out in the sun for drying. Proper drying ensures that the fibres do not develop odours or mould.

Shaded Dry
For higher-quality fibres, drying in shaded, ventilated areas is preferred to prevent discolouration from direct sunlight.

5. SORTING AND GRADING

After the extraction and drying of banana fibres, sorting and grading are essential steps to ensure their quality and suitability for various applications. Sorting involves separating the fibres based on characteristics such as length, texture, colour, and purity. Longer, finer fibres are prioritized for high-quality applications like textiles and luxury handicrafts, while shorter or coarser fibres are directed toward industrial uses, such as rope-making or paper production. Lighter, golden-coloured fibres are often preferred for premium products, while darker or uneven fibres may be allocated for utilitarian purposes. Following sorting, grading categorizes the fibres into quality tiers. Grade A fibres, which are long, fine, and uniform, are used in high-value industries. Medium-quality fibres are classified as Grade B and are used for products like mats and ropes, whereas shorter, coarser fibres (Grade C) serve industrial and composite purposes. Any remaining lower-quality fibres or waste is repurposed for composting or secondary uses like biofuels. By ensuring proper sorting and grading, manufacturers can optimize the use of banana fibres and maximize their economic and functional value.

CONCLUSION:

Banana fibre production is eco-friendly, as it reuses a renewable resource without causing harm to the environment. Manual extraction is highly sustainable for small-scale industries and households, particularly in rural areas where resources are limited. The method has a minimal carbon footprint and allows communities to utilize banana plant waste effectively. Agrowaste, or agricultural waste, refers to the byproducts generated from farming activities. These include crop residues, husks, stems, leaves, and other organic materials that are left unused after the primary agricultural product is harvested. In the case of banana cultivation, the pseudostem, leaves, and fruit peels form a significant portion of the agrowaste.

Banana plants, grown primarily for their fruit, generate a substantial amount of biomass. Each banana plant produces fruit only once in its lifetime, after which the pseudostem is traditionally considered waste. However, this so-called "waste" is a rich source of natural fibres that can be extracted and processed for numerous applications. By utilizing banana agrowaste, the potential environmental harm from disposal is minimized, while simultaneously creating valuable, sustainable products.

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AI POWERED FASHION- EXPLORING POTENTIAL OF AI IN DESIGNING, MANUFACTURING AND RETAIL

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ABSTRACT

AI has made substantial inroads into various industries, offering innovative technology solutions, more efficient operational methods, and access to valuable consumer and industry data. In today's rapidly evolving landscape, organizations that harness the power of AI gain a competitive advantage. Initially, AI automation didn't pique the interest of fashion executives in an industry rooted in creativity and expression. However, as we enter the hyper-digital age, AI applications have the potential to redefine fashion enterprises, leading to substantial growth and revenue compared to those adhering to traditional approaches. Artificial intelligence (AI) promises to revolutionize the fashion industry, optimizing operations, fostering creativity, and enabling smarter decision-making. It contributes revolutionary changes from design to product development. Fashion designers enthusiastically embrace AI-driven advancements, recognizing their potential to reshape the fashion landscape.

Key words – fashion, automation, artificial intelligence, creativity, product development

INTRODUCTION

Fashion is one of the most valuable sectors in the world. It's estimated worth is about $3 trillion, representing 2% of Global Domestic Product (Sennaar 2019). However, this industry has remained quite traditional for decades. As the digital transformation progresses, it is also imposing profound transformations on the fashion industry. In particular, the abundance of data made available by the use of digital technologies has enabled the diffusion of many applications of AI in this industry. Artificial Intelligence (AI) has made significant inroads into a variety of businesses like education, health, fashion, IT, ecommerce etc, providing innovative technology solutions, more effective operational methods, and access to important consumer and industrial data. In today's quickly changing market, firms who embrace the power of AI gain a competitive edge. The impact of AI in fashion extends beyond the numbers, as it fundamentally reshapes how fashion products are conceived, created, marketed, and sold. AI-powered design tools assist fashion designers in generating innovative concepts and predicting consumer preferences. In production, AI-driven automation enhances efficiency and sustainability. Additionally, AI algorithms analyze vast amounts of data to optimize marketing strategies and personalize the shopping experience for consumers. As the fusion of technology and fashion continues to evolve, artificial intelligence (AI) is fast emerging as a transformative force in the fashion industry. According to McKinsey analysis, generative AI could add, conservatively, $150 billion and up to $275 billion to the apparel, fashion, and luxury sectors' operating profits in the next three to five years. AI is set to play in the future of fashion, not just as a disruptor, but also as a value creator. From predicting trends and optimizing supply chains to customizing the shopping experience and enabling virtual try-ons, AI's potential in reshaping the fashion landscape is substantial and varied.

AI in Fashion industry

AI has many potential implications for the fashion industry and many initiatives try to explore these, however, perfect solutions are difficult to obtain. Regarding AI in the fashion industry, research is still limited. AI has shown the potential to be a proper solution for all parts of the value chain in the textile and fashion industries, from early product development to manufacturing (Mohiuddin, et al., 2022). Therefore, it could be argued that AI is at the core of the sustainable and agile fashion industry we need in the future. Nevertheless, the implications and specific benefits are unclear in most research within the field of AI in fashion (Mohiuddin, et al., 2022). The incorporation of AI and robotic technology in the textile industry has ushered in transformative success and profound organisational changes. When utilised effectively in the garment sector, AI can yield substantial benefits. The integration of artificial intelligence, machine learning, robotics, and relevant software can streamline various garment manufacturing processes. As a result, this not only enhances work speed but also ensures that both manufacturers and customers reap greater rewards in a shorter span of time.

Various implementations of artificial intelligence in the fashion industry

From a consumer perspective, AI has impacted the fashion industry in various ways. Platforms such as Stitch Fix uses AI in order to provide personalised and enhanced services for customer satisfaction. AI chatbots for improved interaction of customers are used Tommy Hilfiger whereas, brand like Adidas uses it to create materials and designs. Dior is also one of the brands using AI for trend analysis in marketing. Virtual try on technologies are powered by AI. Additionally, AI driving sizing tools help improve the accuracy of size recommendations, reducing the likelihood of returns and enhancing the overall shopping experience. (Adeena Khan and Armaiti Shukla)

1. **Personalized recommendations:** AI analysis, user preferences, purchase history and browsing his behaviour to provide tailored product recommendations, helping consumers discover items aligned with their style.

2. **Time Saving Shopping:** AI streamlines the shopping processes by presenting curated selections, saving consumer time when finding relevant products and reducing decision fatigue.

3. **Virtual try-ons:** AI powered virtual fitting rooms enable consumers to visualize how clothing items will look on them without physically trying them on, enhancing the online shopping experience and reducing uncertainty about Fit.

4. **Improved Sizing Accuracy**: AI algorithms use data on body measurements and historical fit preferences to recommend accurate sizes, reducing the likelihood of returns and ensuring a better fit for consumers.

5. **Enhance customer Support** Improving overall consumer service by offering Assistant outside regular business. Are guiding users through the shopping journey. Addressing queries. AI driven chat bots provide instant support.

6. **Discovering Unique Styles** AI algorithms analyse trends from a vast array of sources, exposing consumers to unique and emerging styles they might not have discovered through traditional means.

7. **Visual search and inspiration.** Visual search capabilities powered by AI allow consumers to find similar products based on images, fostering inspiration and helping users locate specific items they have seen elsewhere.

8. **Inform purchases:** AI provides consumers with information on product materials, manufacturing practices and sustainability efforts, empowering them to make more informed and ethical purchasing decisions.

9. **Social Shopping Experiences:** AI integrates with social media platforms allowing users to discover fashion trends, share styles and even make purchases directly through the platforms, creating a more social and interactive shopping experience.

10. **Dynamic Pricing Awareness:** Consumers benefit from AI driven dynamic pricing by being aware of price fluctuations, promotions and discounts, helping them make cost effective decisions.

Designing

Recently, AI in fashion garment design has evolved from image recognition and synthesis to image generation (Anantrasirichai & Bull, 2021). GAN has recently attracted attention in the research on AI-based garment design. The GAN model is an unsupervised deep learning method that generates or edits new fake images. GAN is used in the fashion industry to generate new designs or modify specific parts of the design (Liu et al., 2019), create graphics printed on clothing.

Create realistic 3D garments and simulate how they fit and move on different body shapes and poses. It can help you save time and resources, improve your design quality and accuracy, and Showcase your creativity and style.

Countless global fashion brands and film/game production companies such as Hugo Boss, Mango, Adidas, Weta Digital, and Ubisoft use CLO Virtual Fashion solutions, making CLO the unrivaled leader of the virtual garment industry

Trend forecasting

Artificial Intelligence (AI) plays a pivotal role in revolutionizing fashion trend analysis by harnessing the power of data and predictive analytics**.** Here are ways in which AI contributes to and enhances the process of fashion trend analysis:

1. **Data Mining and Collection**
2. **Pattern Recognition**
3. **Real Time Monitoring**
4. **Predictive analytics**
5. **Consumer Behavior analysis**
6. **Market Segmentation**
7. **Competitor Analysis**

The best example of the same is CLO 3D, a powerful software that allows fashion designers to create realistic 3D garments and simulate how they fit and move on different body shapes and poses. It can help you save time and resources, improve your design quality and accuracy, and showcase your creativity and style. Countless global fashion brands and film/game production companies such as Hugo Boss, Mango, Adidas, Weta Digital, and Ubisoft use CLO Virtual Fashion solutions, making CLO the unrivaled leader of the virtual garment industry

Repsketch, is an online vector editing software that generates realistic graphics from your flat sketches. It allows you to change the background, add branding information, material specifications, and so forth. Images generated by AI may also be utilized for presentations and sneak peeks for potential customers

Artiphoria is another example of using Generative AI to create digital artworks. It allows users without graphic design skills to make graphics with a single click. It is an excellent tool for creating artwork that will be printed on garments and accessories

Vmake, on the other hand, is an AI-powered photo and video editing application that allows users to create backdrops and improve photographs and videos for marketing and content development

Stylumia deploys its AI and machine learning platform to help fashion and lifestyle brands forecast demand, spot trends, manage inventory, and make better business decisions

Heuritech analyzes millions of images to give their customers quantitative data on the evolution of the consumer's preferences. Using their platform brands can analyze the predicted visibility growth of shapes, colors, prints, and fabrics, and their forecast market share

Manufacturing

AI is making a big impact on sustainable and customized apparel manufacturing. Modern imaging techniques let end-users make 3D renderings of their body to facilitate cheaper and less resource-intensive custom clothing manufacturing. Generative design is another technology making waves in the apparel industry. Fashion/apparel designers and engineers use an AI algorithm to choose material and performance constraints, then instruct an AI to generate product designs meeting those criteria.

Fabric Inspection and AI

In the garment industry, fabric inspection is typically conducted by skilled workers using specific equipment, under designated lighting conditions. However, this traditional method has its pitfalls. Often, the fabric is not inspected in its entirety, and the human eye can occasionally overlook flaws, leading to defects in the final garment. In contrast, artificial intelligence offers a solution that can operate at both higher efficiency and speed compared to human performance. AI-driven inspection ensures higher accuracy, operates tirelessly, and mitigates the risk of human error. Thus, AI proves invaluable, even at the initial stages of garment manufacturing.

AI-driven ERP Entries

Over the past decade, Enterprise Resource Planning (ERP) systems have seen significant advancements. Artificial intelligence, complemented by computer vision, can greatly enhance ERP systems, streamlining daily operations. AI is adept at tackling complex tasks and managing large datasets. For instance, AI can automate entries based on the bill of materials, oversee and provide feedback to the sourcing team, manage costings, and execute a myriad of other intricate tasks through the ERP system. Such integrations promise substantial efficiency improvements, marking a revolutionary shift for companies aiming to optimise their operations.

Integration of AI with Computer-Aided Design (CAD)

The computer-aided design (CAD) system is pivotal for an efficient garment manufacturing process. It is primarily employed to undertake a sequence of tasks, from pattern creation and design to pattern grading and marker making. The aim is to maximise efficiency in fabric utilisation and garment design. The CAD system, when used alone, substantially enhances productivity, efficiency, and quality compared to traditional manual pattern-making processes.

Incorporating AI in Cutting

As previously discussed in the context of integrating AI with computer-aided design, a parallel AI system can be deployed for cutting and cut order planning. Cut order planning in the garment industry is intricate, but with AI's intervention, this process becomes considerably more straightforward, faster, and efficient. The contemporary market has witnessed the development of various AI-powered software solutions tailored to these needs. For instance, the JAZA software, which is amalgamated with a cut planning system, or OptaCut software, which calculates the fabric quantity needed. Such tools not only aid in ordering the precise amount of fabric rolls but also facilitate automated cut planning.

AI on the Sewing Floor

Integrating artificial intelligence with sewing machines and related equipment has opened up vast opportunities for apparel manufacturers. Sewing machines enhanced with AI can execute intricate operations and alleviate bottlenecks across the sewing line. The influence of artificial intelligence on garment manufacturing is profound. When AI, machine learning, and advanced software technologies are melded with the garment-making process, they confer a host of advantages to manufacturers. Fully automatic sewing machines, AI-integrated conveyor belt systems, and semi-automatic sewing equipment have started to replace human roles, leading to heightened efficiency and productivity on the production line. This synergy between AI and sewing not only bolsters profitability rates but also ensures superior product quality, culminating in enhanced satisfaction for the end consumer.

Predictive Maintenance

AI has the capability to continuously monitor machinery, forecasting when maintenance interventions might be required. This predictive approach enables companies to diminish unplanned downtime and bolster operational efficiency.

Retail

The fashion industry stands as one of the most lucrative sectors globally, boasting a market value estimated at $3 trillion. Despite its glamour, the fashion sector presents a competitive landscape for retailers. The fusion of artificial intelligence with retail and design operations is transforming the industry in ways previously unimagined. A prime example is the adoption of AI chatbots by numerous retailers. AI plays a pivotal role in retail by offering tailored recommendations to customers. By analysing a customer's purchase history and data stored in the cloud, AI systems can make personalised product suggestions, spanning clothing, accessories, and even non-textile items. This not only streamlines the shopping experience for customers saving time, money, and effort but also reduces the need for extensive human intervention. Furthermore, these intelligent recommendations can bolster retailers' sales and revenues by enhancing customer satisfaction.

Virtual Fitting Rooms: In the realm of garment retail, AI-enhanced fitting rooms are gaining traction. These spaces, often accompanied by AI assistants, allow customers to 'try on' clothing virtually, without physically wearing the items. Such innovations, emblematic of 'smart stores', are transforming the retail experience. Moreover, similar virtual fitting technologies are making their way into online shopping platforms. Virtual fitting rooms not only enhance the in-store experience, potentially boosting footfall and sales, but they also drive customer satisfaction through their innovative offerings.

Design Assistance: AI is also making its mark in assisting designers as they craft novel and unique collections. Operating on the principle of trend analysis, AI evaluates current fashion inclinations and customer preferences. This data-driven insight empowers designers to craft bespoke products tailored to individual customer tastes. Additionally, this AI-enabled design assistance gives retailers a competitive edge, ensuring they remain at the forefront of market trends and customer preferences.

Chatbots or AI smart Assistants

The increasing scale and granularity of personalization in online fashion would be impossible to manage without AI applications. The most popular services for personalized online shopping use chatbots or AI smart assistants. These are virtual machines that interact with customers via chat, responding to customer service inquiries, helping users navigate ranges online and in-store, recommending clothing and accessories that best suit a specific customer as if they were human shopping assistants working 24 hours a day

Marketing

AI is also changing the way fashion businesses market their products. With AI-powered marketing tools, businesses can analyze data to determine the best marketing strategies, target the right customers, and maximize the impact of their advertising. This not only saves time and money but also helps businesses get ahead of the competition by identifying new trends and emerging markets. This is an exciting development for the fashion industry, as it means businesses can now reach new customers and generate more sales. With AI algorithms predicting trends and analyzing customer preferences, fashion businesses can create designs that are more likely to be popular with their target market and reduce the risk of producing designs that don't sell.

Supply Chain Management

One of the biggest impacts of AI in fashion is in the area of supply chain management. With AI models capable of being trained by historical inventory levels and sales performance to predict future sales, businesses can make more informed decisions about what to stock and when. This can help reduce waste, improve customer satisfaction, and increase profits

AI App used in Fashion Industry

Amazon's Echo Look is the most known example of a virtual style assistant (Luce 2019 pp.75-79).This hands-free camera is intended to give users feedback on their outfit selection. Using voice commands, Echo look takes a picture of the outfit and gives suggestions on the merit of it, based on trends and professional stylist opinions. It can also make personalized recommendations for better combinations of items based on the outfits available in the user's personal wardrobe or items available on Amazon.

Smart Mirror

Digital technologies are also enhancing customer experience in stores. Fashion luxury brands are using smart mirror technologies in combination with their physical stores. A smart mirror is "a two-way mirror with an electronic display behind it. They are computers enabled by a full stack of technology, from hardware with depth sensing to software equipped with advanced computer vision algorithms" (Luce 2019 p. 39)

Shimmy Technologies

Shimmy Technologies, a Brooklyn apparel and tech startup, has incorporated artificial intelligence to help speed up the swimwear apparel design process. Swimwear is notoriously difficult to measure, and tailors need to take measures multiple times. Shimmy partnered with IBM's Watson AI to develop a system such that when tailors give a measurement to the computer, it creates a 3D model of a design. (Ramirez 2018). These new styles are then evaluated and approved by human stylists before they reach the client

NEUE

NEUE, a Swedish fashion-tech company, that had developed a chip with sensors and processors that enabled the control of electro-luminescent fabric, worked with New York's Fashion Institute of Technology to design a garment and an accessory shown on the red carpet at the Harper's Bazaar Icons event (Cadogan 2018). Smart Textiles are very closely linked to IoT developments. A particularly interesting application of smart fashion techniques is the Live:

Scape BLOOM

An "IoT connected dress whose floral embellishment changes mode over time in response to real-time, meteorological data streams. Live: scape BLOOM uses conventional textile fabrics, jewellery beads and trims, electronics components, a WIFI development kit, servo-motors and custom software" (McMillan 2019). This dress shows the opportunities for wearable, IoT connected shapes as smart fashion. Nano photonics for artificial intelligence can extend the concept to future applications for health, communications and lifestyle.

Challenges

Effects on The Human Workforce

One of the biggest concerns is the potential for AI to replace human labor. With AI algorithms capable of doing the jobs of designers, marketers and other fashion professionals, there is a risk that some jobs will be lost. This could have a significant impact on the fashion industry as a whole, as well as on the broader economy. This is a valid concern, and it's important for businesses to approach AI in a responsible and ethical manner.

Homogenization

Another challenge is the potential for AI to make fashion more homogenized. With AI algorithms driving design and marketing decisions, there is a risk that fashion will become less individual and less creative. This could lead to a decline in the quality of fashion products, as well as a decline in the popularity of the overall industry. This is a genuine concern, and it's up to the industry as a whole to ensure that AI is used in a way that promotes creativity and diversity.

Conclusion:

AI has the potential to redefine the fashion industry by improving operational efficiency enhancing customer experiences, and promoting sustainability. As AI technology evolves and matures, it will become an indispensable tool for fashion retailers, shaping the industry's future. Therefore, fashion retailers must embrace AI and leverage its potential to reshape their business models, increase their market share, and deliver exceptional customer value. Navigating these concerns while leveraging AI's benefits is crucial for successful integration. Striking a balance between addressing ethical apprehensions and capitalizing on Al's transformative potential is essential for building trust among stakeholders. Collaborative efforts between industry leaders, policymakers, and technology developers are vital for developing frameworks that prioritize ethics while harnessing Al for innovation and sustainability in fashion. Proactive and inclusive approaches can unlock Al's opportunities, ushering in a new era of creativity, efficiency, and responsible innovation.

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SUSTAINABILITY INITIATIVES POWERED BY TECHNOLOGY IN THE TEXTILE INDUSTRY

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ABSTRACT:

The textile industry, a significant contributor to global environmental challenges, has undergone a transformative journey toward sustainability through technological advancements. This study explores the intersection of technology and sustainability within the textile sector, examining innovations in production, waste management, resource optimization, and ethical practices. It highlights cutting-edge solutions such as AI-driven design, blockchain for transparency, and sustainable materials development. By analyzing case studies and global trends, this paper provides insights into how technology is driving the shift toward a more eco-conscious textile industry. The findings underscore the potential of technology to revolutionize the industry, aligning it with global sustainability goals.

Keywords: Sustainability, Textile Industry, Technology, AI in Textiles, Blockchain, Eco-Friendly Materials, Circular Economy, Resource Optimization, Ethical Fashion

1. INTRODUCTION

The textile industry plays a pivotal role in the global economy, employing millions and contributing significantly to GDP in many countries. With its multifaceted supply chains and diverse product offerings, the sector has become an integral part of global trade and commerce. However, the industry's environmental footprint remains a cause for concern. The production processes involved in textile manufacturing are resource-intensive, consuming vast amounts of water, energy, and raw materials. Additionally, the industry contributes significantly to pollution, with untreated effluents discharged into water bodies, excessive carbon emissions from energy usage, and mountains of textile waste generated annually.

In recent years, the growing awareness of environmental degradation has intensified the demand for sustainable practices. Consumers and stakeholders alike are increasingly prioritizing eco-friendly and ethically produced textiles. Governments and international organizations are implementing stringent regulations to curb the environmental impact of the textile sector, compelling manufacturers to adopt more sustainable methods.

Technology has emerged as a critical enabler of sustainability in this context. From digital transformation to advanced material science, technological innovations offer a pathway to minimize the environmental impact of textile production. Technologies such as artificial intelligence (AI), blockchain, and automation are not only streamlining operations but also fostering transparency, reducing waste, and enhancing resource efficiency. Furthermore, breakthroughs in sustainable material development, such as bio-fabricated textiles and recycled fibers, are redefining the raw materials landscape of the industry.

This paper explores the multifaceted ways in which technology is being leveraged to address sustainability challenges in the textile industry. By analyzing global trends, case studies, and emerging innovations, the study aims to provide comprehensive insights into how technology is revolutionizing the industry. The discussion underscores the importance of a collaborative approach, integrating technological advancements with regulatory support and consumer engagement to achieve meaningful progress toward sustainability goals.

2. TECHNOLOGICAL INNOVATIONS DRIVING SUSTAINABILITY

2.1. Artificial Intelligence (AI) in Sustainable Textiles

AI is transforming the textile industry by leveraging predictive analytics, streamlining production processes, and reducing waste. By analyzing vast data sets, AI can forecast market trends and demand, enabling efficient production planning. AI-driven design platforms empower brands to simulate product designs virtually, minimizing errors and material waste before production begins. Additionally, AI-powered inventory management systems optimize stock levels, reducing overproduction and the need for disposing of excess goods. This not only curtails waste but also promotes resource efficiency throughout the supply chain.

2.2. Blockchain for Supply Chain Transparency

Blockchain technology offers a transparent and secure framework for enhancing supply chain accountability. By documenting each stage of the production process on a decentralized ledger, blockchain ensures ethical sourcing and manufacturing practices. Consumers can verify the sustainability and authenticity of products, fostering trust in the industry. Companies like Everledger are already leveraging blockchain to track the origin and journey of sustainable fibers, enabling stakeholders to make informed, ethical decisions and encouraging adherence to sustainability goals.

2.3. Development of Sustainable Materials

Innovative materials are at the forefront of advancing sustainability in the textile sector. Bio-fabricated materials such as Mycelium leather and algae-based textiles provide renewable alternatives to traditional materials. Recycled fibers and biodegradable options, like those derived from microbial fermentation, reduce reliance on virgin resources and support a more sustainable lifecycle. These advancements are not only environmentally friendly but also represent significant steps toward reducing the textile industry's ecological footprint.

2.4. Energy-Efficient Manufacturing Techniques

Emerging technologies like 3D knitting and digital textile printing have revolutionized textile production by optimizing energy use and reducing waste. For instance, 3D knitting creates garments in a single process, eliminating fabric scraps, while digital textile printing applies precise amounts of dye, reducing chemical usage and water pollution. These methods enhance precision and sustainability, making energy-efficient manufacturing a cornerstone of eco-friendly textile production.

2.5. Water Conservation Technologies

The traditional textile industry is one of the largest consumers of water, but new technologies are addressing this challenge. Innovations like DyeCoo's CO2-based dyeing process eliminate water use entirely, while closed-loop water systems treat and recycle water within manufacturing plants. These solutions not only conserve water but also reduce environmental contamination, aligning the industry with sustainable practices**.**

2.6. Circular Economy Initiatives

The circular economy model promotes the reuse, recycling, and extension of product lifecycles to minimize waste. Automated textile recycling systems and platforms for upcycled fashion encourage the repurposing of materials, reducing dependency on virgin resources. For example, Worn Again Technologies is pioneering processes to separate and recycle fibers from mixed-material fabrics, supporting a sustainable and regenerative textile economy.

By integrating these technologies and practices, the textile industry is taking significant strides toward sustainability, balancing innovation with environmental stewardship.

3. CASE STUDIES OF TECHNOLOGICAL INTEGRATION:

3.1. H&M's AI-Driven Sustainable Collection

H&M has taken a bold step in integrating cutting-edge technology to address one of the fashion industry's most pressing challenges: sustainability. By leveraging artificial intelligence (AI), the global fashion retailer has transformed its approach to trend analysis, inventory management, and production processes. AI-powered systems analyze vast amounts of consumer data, such as shopping patterns, preferences, and feedback, enabling H&M to predict upcoming fashion trends with remarkable accuracy. This predictive capability allows H&M to design collections that align closely with consumer demand, significantly reducing overproduction—a major contributor to waste in the industry. Additionally, AI helps optimize supply chain operations by ensuring the right quantities of products are delivered to the right locations at the right time. By minimizing excess inventory and streamlining production cycles, H&M has successfully reduced its carbon footprint and resource consumption.

This innovative approach exemplifies how technology can enable sustainability without compromising business goals. H&M's AI-driven strategies are setting new benchmarks for the fashion industry, proving that sustainability and profitability can go hand in hand.

3.2. Levi's Water Less® Technology

As a globally recognized denim brand, Levi Strauss & Co. has demonstrated its commitment to sustainability through its revolutionary Water<Less® technology. Traditional denim manufacturing is notoriously water-intensive, with some pairs of jeans requiring up to 3,800 liters of water to produce. Levi's has tackled this issue head-on by developing innovative methods that drastically reduce water usage during the finishing stages of production. Water Less® employs techniques such as reducing the number of washing cycles, combining multiple wet processes into a single step, and using ozone technology instead of water to achieve the desired fabric finishes. Since its introduction, this initiative has conserved more than 3.5 billion liters of water globally and reused over 5 billion liters within production facilities.

By maintaining the high-quality standards Levi’s is renowned for, the brand ensures that sustainability does not come at the cost of durability or style. Water<Less® technology not only addresses environmental concerns but also resonates with conscious consumers who value eco-friendly fashion. Levi’s has positioned itself as a leader in sustainable innovation, inspiring others in the industry to adopt water-saving practices.

3.3. Stella McCartney’s Blockchain Collaboration

Renowned for her dedication to sustainability and ethical practices, Stella McCartney has taken her commitment to the next level by integrating blockchain technology into her supply chain. This groundbreaking collaboration with blockchain providers ensures unprecedented transparency and accountability throughout the production process. Blockchain technology operates as a decentralized digital ledger, recording every step of the supply chain in an immutable and tamper-proof format. For Stella McCartney, this means that every material used—be it organic cotton, recycled polyester, or vegan leather—can be traced back to its source. Consumers can verify that the raw materials are sustainably harvested, free from deforestation, and produced under fair labor conditions.Furthermore, blockchain empowers stakeholders by offering real-time data on the environmental and social impact of production. For instance, the carbon footprint of a garment can be tracked from its raw material stage to its final delivery. This level of transparency builds trust with consumers, who are increasingly demanding proof of ethical and sustainable practices from brands they support.

Stella McCartney’s adoption of blockchain sets a precedent for the luxury fashion industry, demonstrating how technology can be harnessed to ensure sustainability, promote ethical manufacturing, and foster consumer trust. The initiative underscores the brand’s role as a pioneer in redefining what luxury fashion means in the 21st century.

4. CHALLENGES AND OPPORTUNITIES

While technology holds transformative potential for the textile industry, its widespread adoption is not without significant challenges. One major hurdle is the high initial cost of implementing advanced technologies such as AI, IoT, or blockchain. For small and medium enterprises (SMEs), which form a substantial part of the textile industry, these costs can be prohibitively expensive, limiting their ability to compete with larger, well-funded players.Resistance to change also poses a barrier, as traditional mindsets and entrenched processes can create reluctance to adopt new methods. Coupled with a lack of skilled personnel trained in emerging technologies, this slows progress and innovation within the industry. Many regions still face a skills gap, where the workforce lacks the expertise needed to operate, manage, and maximize the benefits of advanced technological systems.

However, these challenges present opportunities for growth and collaboration. Governments, technology providers, and the textile industry can join forces to address these issues through well-designed incentive schemes and policy interventions. For example, subsidies or tax breaks for adopting sustainable technologies can lower financial barriers for SMEs. Public-private partnerships can also play a pivotal role in developing training programs to upskill workers, ensuring that the industry is equipped with a tech-savvy workforce capable of driving innovation.Moreover, global sustainability frameworks, such as the United Nations Sustainable Development Goals (SDGs), provide a roadmap for aligning technological advancements with ethical and environmental priorities. Encouraging collaboration between stakeholders at every level can accelerate the adoption of technology-driven solutions, enabling the textile industry to navigate challenges and seize emerging opportunities.

4.1. Future Outlook

The future of sustainability in the textile industry is marked by immense potential, driven by the emergence of groundbreaking technologies. The Internet of Things (IoT) is expected to revolutionize the sector through the development of smart textiles—fabrics embedded with sensors that can monitor wear and tear, track usage patterns, and even provide insights for optimizing garment care. By promoting reuse and recycling, IoT-enabled textiles can extend product lifecycles and reduce waste, contributing to a circular economy.

Nanotechnology is another transformative force, offering innovative solutions that could redefine the industry's sustainability standards. Self-cleaning fabrics, for instance, reduce the need for frequent washing, saving water and energy. Similarly, energy-harvesting materials embedded within textiles could power wearable devices or even contribute to renewable energy generation. These innovations align with growing consumer demand for functionality and eco-friendliness in their purchases.

Global cooperation and the implementation of stricter regulations will further push the textile industry toward achieving environmental and ethical benchmarks. As countries adopt comprehensive sustainability policies and enforce compliance with international standards, companies will be incentivized to invest in green technologies. Collaborative efforts, such as knowledge sharing, joint research initiatives, and partnerships, will play a key role in accelerating progress.

The road ahead for the textile industry is one of transformation, where challenges are met with innovation, and opportunities are harnessed to create a more sustainable future. By embracing these emerging technologies and fostering a culture of collaboration, the industry can position itself as a leader in addressing the environmental and social imperatives of our time.

5. CONCLUSION

Technology has become a pivotal enabler in the journey toward sustainability for the textile industry, addressing long-standing environmental and ethical challenges. Advancements such as artificial intelligence (AI), blockchain, and bioengineering are not merely tools but transformative agents capable of reshaping traditional practices and driving the industry toward a greener future. AI optimizes supply chains and reduces waste, blockchain ensures transparency and ethical sourcing, and bioengineering introduces innovative materials that are both functional and eco-friendly. The analysis presented in this paper highlights the critical need for sustained innovation and collaboration among all stakeholders—including manufacturers, governments, technology providers, and consumers. To ensure that technological solutions achieve their full potential, they must be both scalable and accessible, enabling small and medium enterprises (SMEs) to participate in the sustainability revolution. Collaborative efforts, such as incentivizing research and development, establishing global sustainability frameworks, and fostering public-private partnerships, are essential for overcoming existing barriers. The transformative potential of these technologies is profound. By integrating cutting-edge innovations with sustainability principles, the textile industry can significantly reduce its ecological footprint while continuing to fuel economic growth. This dual focus on economic resilience and environmental stewardship positions the industry as a key player in addressing global sustainability challenges. Moreover, the adoption of technology-driven solutions does not merely benefit the industry; it aligns with broader societal goals, contributing to a circular economy and promoting ethical practices across supply chains. As consumers increasingly demand sustainable and transparent products, the integration of these technologies will also serve as a competitive advantage, fostering trust and loyalty in the marketplace.

In conclusion, the textile industry stands at the threshold of a new era where technology and sustainability converge to create lasting impact. Through a comprehensive and forward-thinking approach, the industry has the opportunity to redefine its legacy, ensuring that economic progress goes hand in hand with environmental responsibility. The path forward is clear: embracing innovation, fostering collaboration, and committing to a shared vision of a sustainable future.

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ERI SILK: THE UNIQUE NATURAL FIBER

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Abstract:

India holds a significant position in tropical sericulture, standing out globally as the only country producing all four varieties of natural silk: mulberry, tasar, eri, and muga. Among these, eri silk is unique as a staple fiber, unlike the filament nature of other silks. This fiber boasts a coarse yet fine and dense texture, making it exceptionally strong, durable, and elastic. Eri silk is distinguished by its darker and heavier appearance compared to other silks and is highly valued for its thermal properties, offering warmth in winter and coolness in summer.Composed primarily of fibroin and sericin, with traces of waxy substances, mineral salts, and pigments, eri silk exhibits remarkable characteristics, such as fineness, density, cross-sectional shape, and unique surface properties. These features enhance its suitability for various end uses. It holds immense potential for commercial applications, including the production of high-quality blankets, sweaters, and suiting fabrics. Additionally, eri silk blends well with other fibers, opening avenues for creating innovative blended materials.Eri silk is gaining popularity due to its eco-friendly nature. Harvested without disrupting the natural life cycle of the silkworm, it is often referred to as "peace silk." This sustainable approach aligns with the growing global demand for environmentally conscious products, making eri silk a promising choice in the textile industry.
Key Words: Eri silk, Properties, uses

Introduction:

Eri silk (Samia ricini), a wild silkmoth, offers numerous benefits and is cultivated through its complete life cycle. Eri silk is characterized by its smooth texture, shiny appearance, and white color. Due to its crimped structure, spun yarns made from eri silk are often blended with other fibers, such as cotton. This silk stands out for its lightweight nature, soft and smooth feel, excellent thermal properties, and ability to absorb sweat effectively, providing good ventilation. The dyeing and physical properties of eri-cotton blended yarns vary based on the physical characteristics of both fibers and their blend ratios .Thailand, with its vast cassava plantations covering approximately 1,600 million square meters, generates significant amounts of cassava leaves as waste. Since cassava and castor leaves serve as feed for eri silkworms, cultivating eri silk could provide farmers with an additional source of income.

Moisture management properties are crucial for textile materials as they facilitate the movement of liquid moisture from the skin through the fabric to the environment, ensuring wearer comfort.Researchers have extensively studied the effects of fiber type, physical properties, yarn variables, and fabric structure on moisture management . Onofrei et al. examined how fabric type and structure influence the thermo-physiological properties of knitted fabrics made from Coolmax® and Outlast®, concluding that knit structure significantly impacts wicking ability compared to other parameters. Furthermore, investigations into bamboo-cotton knitted fabrics revealed that increasing bamboo content reduces wetting time, maximum wet radius, spreading speed, and Overall Moisture Management Capability (OMMC), while absorption rates improve.

Eri Silk Cultivation

Silk is a protein-based fiber known as fibroin, produced by silkworms. The life cycle of a silkworm comprises four key stages: egg, larva, pupa, and moth. During the pupa stage, the silkworm creates a protective casing called a cocoon by spinning silk in a figure-eight pattern, formed from a protein fluid it secretes. The life cycle of the eri silkworm varies with the season, lasting approximately six weeks in summer and extending to twelve weeks in winter.

Eri silk and its blends

Silk, known for its fineness, luster, and strength, surpasses wool in these properties. Blending silk with wool produces bulkier and more affordable yarns compared to pure spun silk. Silk competes effectively with wool due to its superior elasticity, brilliant colors, resistance to pilling, strength, and colorfastness Eri/acrylic blended yarns have been created at varying blend ratios, showing that the tenacity of the yarn decreases as the proportion of eri fiber increases, as eri is comparatively weaker than acrylic. However, breaking elongation improves with an increase in yarn coarseness . Similarly, eri and cotton fibers are blended using draw-frame blending at different ratios (0–100%) and yarn counts (30 and 50 tex). The results indicate that the longer and stronger eri fibers influence the fiber distribution in the yarn cross-section, with mechanical properties improving significantly when silk content exceeds 50%.Notable advancements in eri silk spinning include the establishment of two eri spun-silk mills in Hindupur, Andhra Pradesh, and Kokrajhar, Assam, as well as another mill in Chaygaon near Guwahati, Assam. These mills specialize in producing the finest eri spun-silk yarn, often blended with bamboo and muga silk.

Physical Properties of Eri Silk Fiber

Weight:

Fresh eri cocoons weigh approximately 3–5 grams, with a shell content of 11–14%. The shell weight varies between 0.4 to 0.6 grams.

Yarn Count:

The fiber has a denier of 2 to 3, with a tenacity of 3 to 3.5 g/denier and an elongation of 20–22%. The higher elongation and shrinkage properties make it suitable for blending with other fibers . Additionally, the tenacity and elongation range from 2.5–3.5 g/denier and 30–40%, respectively, with a moisture retention capacity of 11%

Luster and Smoothness:

Eri silk fibers exhibit remarkable characteristics, including a natural luster, exceptional smoothness, and excellent moisture absorbency. Its brilliant shades enhance its resilience, making it highly attractive. Eri silk is finer than muga and tasar silk and is even softer than mulberry silk.

Elastic Recovery:

Eri silk is known for its excellent elastic recovery, making it one of its most appealing properties.

Uses of Eri silk

Eri silk mostly used for the preparation of winter shawls for men and women in India, The thermal properties of eri silk make it a suitable fabric for shawls, jackets, blankets, and bed spreads. Dress materials and baby dresses are also made from eri silk fabric because of its soft texture and moisture absorbent quality. Now-a-days, very fine (up to 210 Nm eri spun yarns are available, which enables weavers to weave very fine clothing, including traditional sari dress materials. Eri silk is durable and strong and has a typical texture; hence, it is also widely used in home furnishing like curtains, bed covers, cushion covers, wall hangings, quilts, etc. Its woolly feel adds to the comfort of these furnishing products. Now-adays, many contemporary products like wallets, bags, belts are also being manufactured using eri silk.

CONCLUSION

Eri silk, known for its unique properties, offers remarkable versatility and sustainability, making it a valuable material in the textile industry. Its thermal insulation, soft texture, and durability make it ideal for producing blankets, sweaters, and suiting fabrics. The fiber’s ability to blend seamlessly with other materials, such as cotton, wool, and acrylic, enhances the mechanical properties and widens its application range. Eri silk’s excellent moisture absorption, elasticity, and smoothness ensure superior comfort, making it suitable for garments and home textiles.

As "peace silk," harvested without harming silkworms, it aligns with the growing demand for eco-friendly and cruelty-free products. Its adaptability for dyeing and ability to create vibrant shades enhance its aesthetic appeal. Additionally, eri silk contributes to rural economies by utilizing agricultural byproducts like cassava and castor leaves. The establishment of specialized spinning mills has further boosted its commercial potential. Eri silk’s combination of sustainability, functionality, and luxury underscores its importance in modern textiles.

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HERBAL HEEL SLEEVE WITH ANTI MICROBIAL FINISHING USING INDIAN NETTLE ON COTTON FABRIC

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ABSTRACT

A natural antimicrobial finishes has been prepared from natural extract for textile application. The natural bio-active agent such as **Acalypha indica** (INDIAN NETTLE) extract of herbal product for antimicrobial finishes of textile substances. Herbal product from Acalypha indica has been applied to cotton fabric by the method of direct application in wet condition, the extract shows the antimicrobial activity. After investigation of COTTON HEEL SLEEVE of antimicrobial finish has been used by the patients cracked feet and the results have been observed that cracked heeling action is good on Acalypha indica.

Key words:
Acalypha indica, Antimicrobial finishing, cracked feet

INTRODUCTION

Textile is the basic needs of human being. It has such an important bearing on our daily lives that everyone needs to know something about them. From earliest times people have used textiles of various types for covering, warmth, and personal adornment .Textiles are used to protect our body from environment. The textile industry is challenged by the presence of microorganism and the negative effect they cause deterioration, defacement, older and other health related problem occur due to the microbes present on cynical fabric towels and applied fabric. In textile finishing refers to the processes that convert the woven or knitted fabrics into a usable material and more specifically to any process performed after dyeing the yarn or fabric to improve the look, finished textile product or clothing. Treatments given to textile material to improve their appearance, feel and qualities are referred to as textile finishes.

METHODOLOGY

PREPARATION OF FABRIC

Fabric preparation improves wet ability of fabric thereby facilitates uniform finishing. The aim of preparatory process is the first step towards quality, which removes the starch, natural impurities and natural yellowish gray coloring matter present in fabric and modifies the fabric forfollow up process. Pretreatment of cotton fabric contain primary, secondary impurities as showin table below and purpose of desizing and scouring is to remove these impurities.

DESIZING

Desizing is done in order to remove the size from the warp yarns of the woven fabrics. Warp yarns are coated with sizing agents prior to weaving in order to reduce their frictional properties, decrease yarn breakages on the loom and improve weaving productivity by increasingweft insertion speeds. The sizing material present on the warp yarns can act as a resist towards dyes and chemicals in textile wet processing. It must, therefore, be removed before any subsequent wet processing of the fabric.

SCOURING

The process of removing natural's oil, wax, fats, gum etc as well as added impurities during fabrication process to produce hydrophilic and clean textile materials is called scouring. It is very vital process of wet processing.

BLEACHING

Bleaching, a process of whitening fabric by removal of natural colour, such as the tan of linen, is usually carried out by means of chemicals selected according to the chemical composition of the fibre.

COLLECTION OF PLANT MATERIAL

The plant of kuppaimeni leaf was collected from Vilundamavadi. The plant was identified based on its morphological characteristics.

PREPARATION OF PLANT POWDER

The Indian Nettle leaf l were sun-dried. After drying at 37°C for 24 hrs the plant material was ground in a grinding machine made for the laboratory. Exposure to direct sunlight was avoided to prevent the loss of active components

NOMENCLATURE

TABLE

S.NO	SAMPLE	NOMENCLATURE
1	INE	INDIAN NETTLE EXTRACT

MATERIALS USED FOR FINISHING

Cloth accurately used for 33neumonia was boiled in 1% of bleaching powder were weighted for 15 mins. The temperature was maintained at 60°C to remove starch from the fabric.Then washed with cold distilled water. The cloth was dried in sunlight. Cotton was dyed with separately plant leaves extract with and without mordant respectively.

ANTIMICROBIAL ACTIVITY OF INDIAN NETTLE

A. indica leaves, root, stalk and flower, which include constituents like **acalyphine**, triacetoneamine, cyanogenic glucosides, and alkaloids, are highly valuable for medicinal applications, due to their anti inflammatory and antimicrobial properties. The earlier studies on the extracts of Acalypha indica confirm its antimicrobial properties against pathogenic bacteria such as Escherichia coli (E. coli), Salmonella typhi (S. typhi), Pseudomonas aeruginosa (P.

aeruginosa), Staphylococcus aureus (S. aureus) and Bacillus subtilis (B. subtilis) .The medicinal applications of herbal nanoparticles with exotic textural characteristics are validated by coating these nanoparticles onto cotton fabrics. The different antimicrobial, hydrophobic and wound healing properties are explored in nanoparticles coated fabrics. The recent studies on the self-cleaning, water repellent, high durability, antibacterial and UV protection properties, etc., of the herbal nanoparticles coated textiles strongly suggest their application in medicine Kuppaimeni is a kind of herb.

Two bacterial cultures, namely, Gram-positive S. aureus (ATCC 6538P) and Gram-negative E. coli (ATCC 9677), were obtained from the National Collection of Industrial Microorganisms (NCIM) (National Chemical Laboratory, Pune, India). The obtained bacterial cultures were further sub-cultured several times at 37 °C for 24 h. Inoculation of a loopful of test organisms into nutrient broth was carried out to prepare fresh bacterial inoculums, and then incubated at 37 °C for 5–8 h till a fair turbidity was obtained. Fresh cultures were swabbed on a nutrient agar plate and then herbal particles of different concentrations (25, 50 and 100 mg mL^{-1}) were loaded onto the well punctured in the nutrient agar plate. After 24 hr of incubation, zones of inhibition around the herbal nanoparticles loaded onto the agar well were measured using a millimeter ruler.

DRY CRACKED FEET FUNGUS

Problems affecting feet are numerous. Besides discomfort, pain, itchiness, and other symptoms they bring, problems such as dry cracked feet fungus also have a major impact on a person’s confidence. People with toenail fungus and similar feet-related problems feel subconscious about their looks, especially during summer. Cracked heels can seemingly pop up out of nowhere, and they're especially difficult during the summer when they're constantly exposed in sandals. It could also be the result of a fungal infection. "Many people assume if they suffer from dry or cracked heels,. Common symptoms of athlete's foot include dry-looking skin, itching between the toes, peeling skin, inflammation, and blisters and if you have symptoms that don't improve within two weeks. Dry, cracked, and painful feet are a common occurrence, especially in women. A wide range of factors causes cracked feet and heels. Some people can have dry cracked feet due to a medical condition such as diabetes, but also because they’re overweight or obese. Eczema, hypothyroidism, Sjorgen’s syndrome, and standing for a long period of time can also make your feet cracks.

Before you dive into learning about how to treat cracked heels, it's also important to note that they're easier to prevent than to get rid of. The best ways to prevent cracked heels include avoiding walking barefoot in public or wearing dirty socks, both of which can both expose feet to bacteria and fungal organisms In addition.

SOLUTION FOR DRY CRACKED FEET

Fungal infections are a major cause of dry and cracked feet. Fungal infections can affect the heel, area under toes, sides for feet . You may have fungal infections of your feet or toenails if they appear to be thickened, whitish or yellow, and you notice foot odor. The heels tend to be rough and cracked, while nails become brittle when you have nail fungus on your toes.One of the most common types of fungus is an athlete’s foot , which tends to begin between the toes first.

Besides the unappealing appearance of feet, fungal infections can also cause discomfort and pain in some people. If you've ever had cracked feet , then you know how painful they can, especially when you're walking or standing too long. . The quality and material matter a lot in this case. Feet are cracked, rough, and thickened, then need to wear cotton socks . Nowadays, different kinds of socks on the market where cotton is only one of the materials, but that's not good enough. You need 100% cotton socks in bed. Wearing these socks cracked feet can keep the moisture in, allow the skin to breathe, and prevent bed sheets from becoming stained. If you repeat this routine regularly, your feet will be noticeably softer. Taking care of infections and eliminating cracked skin should be accompanied with these measures that aim to restore hydration. Wear socks made out of breathable fibers, such as cotton fibers that wick moisture away for skin, wrap their feet with plastic wrap, and wear socks or heel sleeve to bed,"

TABLE 1.
EFFECT OF ANTIMICROBIAL ACTIVITY

S.No.	Bacteria	Zone of Inhibition(mm in diameter)		
		control	Standard*	1
1	Bacillus Subtilis	-	18	20
2	Escherichia coli	-	20	22
3	Klebsiella pneumoniae	-	21	18
4	Staphylococcus aureus	-	17	19

TABLE 2.
EFFECT OF ANTIMICROBIAL ACTIVITY

S. No	Bacteria	Zone of Inhibition (mm in diameter)		
		Control	Standard*	1
1	Bacillus Subtilis	-	18	20
2	Escherichia coli	-	20	22
3	Klebsiella 41neumonia	-	21	18
4	Staphylococcus aureus	-	17	19

CONCLUSION

In this study, conclusion of this project is to give an antimicrobial finish to Herbal heel sleeve finishing application on cotton fabric,to provide a medical textile for the person with cracked feet.From the result of this thesis it is concluded that the Acalypha indica leaves are having extreme antimicrobial potency against human pathogenic bacteria such as Bacillus Subtilis,Klebsiellapneumoniae, Escherichiacoli,Staphylococcusaureus. The cotton fabric was selected for the study, present moisture and obserbency,softness for feet. After extracting the cotton fabric were processed equally by finishing with natural herb Indian nettle. The plant extract studied could be answer to the people seeking for better and no side effects. In the present study, Acalyphaindica can effectively used for healing of cracked feet bacterial diseases.

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A STUDY ON THE MARKETING STRATEGIES OF FAST-MOVING CONSUMER GOODS IN THANJAVUR DISTRICT

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ABSTRACT

FMCG is one of the major pillars of the Indian economy. In the last few years, the Fast-Moving Consumer Goods market has been growing at a rapid pace due to the growing awareness, easier access and changing lifestyles. The key growth drivers for this sector include vibrant government initiatives and polices. FMCG sector provides employment to around 3 million people accounting for approximately 5% of the total factory employment in India. FMCG consist of various consumable goods like food products, packed food products and drinks etc. This sector mainly depends on the consumer preference and satisfaction. Hence every year, these industries invest more and more in advertisement to establish a strong customer base and also a strategy to reduce the market competition, It has been witnessed from this study that FMCG companies in India have increased their marketing strategies for sales promotions and advertisements. This study examines the relationship between marketing strategies and profitability and sales of FMCG in Thanjavur district. FMCGs should consider the effectiveness of advertisement, product availability and competition in the market to maximize its impact on profitability and sales.

Key Words: Fast Moving Customer Goods, FMCG Market, Marketing Strategies

INTRODUCTION

Fast Moving consumer goods are those goods that are consumed every day by the average consumer and are replaced or fully used up over a short period of days, weeks, or months, and within one year. The Fast-Moving Consumer Goods, also known as Consumer-Packaged Goods, is products that have a quick turnover and relatively low cost. Though the absolute profit made on FMC Goods is relatively small, they generally sell in large numbers and so the cumulative profit on such products can be large. Fast moving consumer goods have a short shelf life, either as a result of high consumer demand or because the product deteriorates rapidly. The FMCG industry is the 4th largest sector in the Indian economy, employing around 3 million people. Key FMCG product categories include household and personal care, healthcare, and food and beverages. The FMCG market in India is expected to reach $220 billion by 2025, growing at 14.9% CAGR. Factors like rising incomes, urbanisation, and changing consumer preferences are driving the growth of the FMCG sector in India.

FAST MOVING CUSTOMER GOODS

FMCG stands for Fast Moving Consumer Goods. These are products that are sold quickly at relatively low cost. They have a short shelf life, either due to high consumer demand or because they perish rapidly. Some Fast-moving consumer goods such as meat, fruits and vegetables, dairy products and baked goods are highly perishable. Other goods such as alcohol, toiletries, pre-packaged foods, soft drinks and cleaning products have high turnover rates. Fast moving consumer goods are products that have a quick shelf turnover, at relatively low cost and don't require a lot of thought, time and financial investment to purchase. The margin of profit on every individual Fast moving consumer goods is less. However, the huge number of goods sold is what makes the difference. Hence profit in Fast moving consumer goods always translates to number of goods sold. Fast Moving Consumer Goods is a classification that refers to a wide range of frequently purchased consumer products. Examples of FMCG generally include a wide range of frequently purchased consumer products such as toiletries, soap, cosmetics, teeth cleaning products, shaving products and detergents, as well as other nondurables such as glassware, bulbs, batteries, paper products and plastic goods. Household and personal care is the leading segment, accounting for 50% of FMCG sales in India. Healthcare (31-32%) and food & beverages (18-19%) are the other major segments. Growing awareness, easier access, and changing lifestyles are the key growth drivers for the sector.

MARKETING STRATEGY

A Marketing strategy is a plan of action designed particularly for achieving marketing objectives in an organization or a firm. Marketing strategies play a vital role in the organization's growth. It is very important for an organization to forecast the future while implementing the strategies.

SCOPE OF THE STUDY

As the Fast-Moving Consumer Goods are low priced and many brands and companies are involved in the manufacturing and production of same categories of products, it becomes really difficult to project a special place in the minds of the consumers. Therefore, marketers have to think of special plans and ways in which they can attract consumers towards their products even at the time of normal economic circumstances or at the time of boom in the economy. Therefore, at the time of recession, the difficulties increase even more. As we all have seen or heard about the most recent recession that has affected the world economy really badly, it became difficult for many industries to survive. Similar is the case with FMCG as well. As it is a low priced and high-volume area to work upon, it became really difficult for sellers to make or increase the profit margin regarding the same. The purpose of this study was to examine the relationship between marketing strategy and how it drives sales effectively.

The purpose of this study was to examine the consumer behaviour of young women in the apparel FMCG market and to identify the key factors that influence their purchase decisions.

GOVERNMENT PAVES THE WAY FOR GROWTH OF FMCGs

The Indian government has been taking several steps to support the growth of the FMCG industry. The fast-moving consumer goods industry is a key pillar of the Indian economy. With its strong growth prospects, resilient nature, and ability to touch the lives of millions, the FMCG sector is poised for an exciting future. As the FMCG sector continues to grow, it presents numerous investment opportunities in the Share Market. Investors can look to benefit from the sector's resilience and strong performance by keeping an eye on key FMCG stocks for potential growth.

MARKETING STRATEGIES TO PROMOTE FMCG

User Generated Content: Now a days the companies talk to their customers by using social media. It's not just about one-way advertising anymore, it is about having conversations. Brands can leverage these conversations as user generated content to promote their products.

Content Marketing Strategy: By using content marketing strategy can get more organic growth and boost traffic. It includes different kinds of content like blog posts, you tube videos, articles, guides, and updates about your photos. For example, if you have a skincare brand, your content plan could have weekly blog posts about skincare tips, you tube videos showing how to use your products and product launch updates. This way you may keep your customers informed and make them feel connected to your brand.

Customer Centric Marketing: It makes customer happy is very crucial nowadays. If they didn't satisfy or get a good experience with your product, they will switch over to another. Research shows that who have a positive brand experience are likely spend 140% more than other customers. Hence, creating a positive customer experience can lead to increased customer loyalty and higher spending.

Power Of Social Media Strategy: Strong social media plays a significant role in FMGCs. Social medias like Instagram, you tube or reddit. Each platform needs its different marketing strategies. For example, if your platform is Instagram, you can put up pictures of your product in an catchy captions. It helps to share your product information and build a community of loyal customers.

Email Marketing: By using email marketing, can make customer to engage and persuade effectively. It provides FMCG products with a means to personalize communication, address specific customer behaviours and ultimately drive conversions. With this email, Starbucks used compelling images and messages to capture customers' attention and generate excitement around the product.

Pricing And Offer: you can also give compelling offers and discounts to captivate your audience. For example, Quiz and games, polls, Giveaway and contests etc. Utilize social media for community-oriented events that can set your FMCG brand apart from competitors and establish better brand awareness, strengthening your position in the market.

Invest In Influencer Marketing: 37 percent of consumers trust social media influencers over brands. Partnering with the right influencers can generate good ROI for your business. For example, if your FMCG brand sells healthy snacks, teaming up with a fitness influencer is a smart idea. They can make fun videos or posts showing how your snacks fit into a healthy lifestyle. It not only makes your brand more trustworthy but also introduces it to a bigger audience.

List On Market Places: If your products have eCommerce website, it allows your customers to explore your products, view their ingredients and check the prices. Approximately 94% of customers rely on Amazon reviews when considering a purchase. In addition to an eCommerce website, developing a shopping app for your FMCG store or brand is another way to tap into the world of online commerce while maintaining a retail store. By offering an application that facilitates both online browsing and local delivery from your local store, you can significantly enhance the shopping experience for your customers, making it more convenient and accessible.

Sell On Branded Website: Branded website is one of the most important marketing assets you can build for your FMCG products. This is where you can showcase your products, tell your product story, can collect leads and drive conversions without competing with anyone else.

A brand website is one of the most important marketing assets you can build for your FMCG products. This way, its easy for customers to find you and get in touch.

CHALLENGES OF FMCGs SECTOR

Evolving Consumer Needs: Rapidly changing and increasing consumer preference and purchase behaviours and demand for healthier, organic, ecofriendly products putting pressure on volumes in certain categories of products.
Distribution Challenges: Inadequate infrastructure and supply chain bottlenecks, counterfeit products, fragmented distribution networks leading to high costs.
Competition and profitability: Need for continuous innovation to stay ahead of competition. Pressure on margins due to rising input costs and intense competition in both from domestic and multinational marketers.
Uncertainties in Policies: Frequent changes in regulations related to labelling, pricing, proposed bans on single use plastics, impacting packaging, stickers environmental norms and increasing compliance costs are the major challenges faced by the FMCG sectors.

CONCLUSION

The world of Fast-Moving Consumer Goods is dynamic and highly competitive and staying ahead requires a deep understanding of different marketing strategies. The study found that advertising and promotional expenses had a significant impact on sales growth, especially in the rural sector, and that celebrity endorsements could boost sales. Despite the economic downturn, FMCG products have remained resilient due to advertising and promotional strategies. By embracing these strategies, FMCG product can navigate the competitive landscape and emerge a s leader in the industry, connecting with customers and achieving sustainable growth. And also, these strategies empower FMCG to connect with their audience authentically, build trust and drive sales.

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THE CHANGE OF DIGITAL MARKETING WITH ARTIFICIAL INTELLIGENCE

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ABSTRACT

Artificial intelligence (AI) and machine learning technologies are increasingly gaining importance for accurately analyzing consumer behavior and delivering customized advertising content within digital marketing strategies. A rapid increase has been observed in the recent research concerning machine learning and artificial intelligence in the digital marketing literature. This research aims to strategically and thematically present a scientific map of publications using digital marketing, machine learning, and artificial intelligence. For this purpose, the Bibliometric analysis method, one of the quantitative research methods, has been used in the study. The most frequently used words are artificial intelligence, marketing, machine learning, commerce, digital marketing, learning systems, machine learning, decision-making, e-learning, and deep learning. Moreover, a co- occurrence network exists between machine learning, marketing, artificial intelligence, digital marketing, and commerce. The involvement of numerous authors from diverse journals suggests that the topic attracts attention from multiple fields. This study offers an extensive bibliometric analysis to visualize the academic publication landscape of digital marketing, machine learning, and artificial intelligence. Subsequent research is expected to emphasize the real-world applications of these technologies in various industries. The visualization of the data obtained from the analyses in this research holds significance for guiding future studies in this area.
Keywords: Digital Marketing, Artificial Intelligence, Machine Learning

Introduction

Amidst the fast-paced progress of technology in the modern era, businesses are employing various tools to make their digital marketing strategies more innovative and effective. One such tool is machine learning, a specialized area within artificial intelligence that enables algorithms to analyz data, learn from it, and make predictions (Kumbure et al., 2022).

The increased research in this area brings a broader perspective to the literature.

This study aims to reveal the contributions of researchers in the relevant scientific field by conducting a bibliometric analysis of publications in the Scopus databases with “digital marketing, artificial intelligence, and machine learning” as keywords in their titles, abstracts, and keywords. Additionally, the study Aims to identify research trends, provide a comprehensive view of research in this area, and introduce its various aspects. It also seeks to identify focused aspects and different directions, thereby contributing to researchers in determining the areas where future studies will concentrate.

1. Developments in Digital Marketing

Artificial intelligence has evolved into a crucial instrument for enhancing customer experience. AI-powered applications like chatbots and virtual assistants can interact with users, providing quick and personalized responses, thereby increasing customer satisfaction. Additionally, AI can extract meaningful insights from data streams like social media and client reviews, offering strategic recommendations to marketers to enhance customer satisfaction (Nwachukwu & Affen, 2023). Besides that, artificial intelligence holds great potential for automating digital marketing processes. AI (Artificial Intelligence) based automated marketing systems can identify potential customers, offer personalized offers, and strategically increase sales conversions. This enables marketers to work more efficiently and assists in optimizing sales processes.

1.1. Target Audience Determination

Target audience determination enables a business to focus its marketing activities on a specific group or segment to promote its product or service. This segment can be based on the potential customers' demographic, geographic, psychographic, or behavioral characteristics (Nirmalasari et al., 2022). Target audience identification is crucial for determining marketing strategies and tactics. A Target audience identification helps optimize the effective utilization of marketing budgets. Focusing on a specific target audience allows for a more efficient allocation of marketing resources. A business can optimize ad spend and achieve higher conversion rates by directing advertising and marketing campaigns to the right segment (Dorokhova et al., 2023). Target audience identification can provide a competitive advantage to a business. Focusing on a correctly identified target audience can differentiate a business from its competitors with a unique value proposition. Developing customized marketing strategies tailored to the target audience creates a competitive advantage and captures the attention of potential customers (Denga et al., 2022). Thus, digital marketing aims to reach and engage with the target audiences determined by businesses. This principle includes using appropriate channels, personalized messaging, and meeting the target audience's needs. The fundamental step of a digital marketing strategy is setting objectives and analyzing the target audience. A marketing strategy can be shaped by identifying the target audience's demographic characteristics, interests, behaviors, and needs.

1.2. Content Marketing

Content marketing aims to create brand awareness, strengthen customer relationships, and increase the conversion of potential customers by providing valuable, engaging, and informative content to the target audience. Content marketing allows businesses to tell their brand stories and provide valuable information to the target audience. Creating and sharing high-quality content enhances brand awareness and establishes the brand as an authority in the industry. Therefore, content marketing aims to establish a connection with the target audience by creating captivating and valuable content. Interaction occurs when users comment on, share, or engage with the content. Content marketing includes creating blog posts, videos, and infographics to attract user interest and increase brand awareness. Blogging aims to communicate with the target audience regularly through an updated blog.

Content strategy involves creating compelling and valuable content for the target audience, determining the channels, preferred content types, and distribution methods.

1.3. Search Engine Optimization

Search Engine Optimization (SEO) is a set of techniques and optimization processes to ensure that a website ranks higher in organic search results. SEO aims to help search engines better understand the website and provide users with higher quality, relevant, and valuable content. Therefore, ranking high in natural search results is essential in driving organic traffic, attracting potential customers, identifying the keywords that potential customers use in search engines, optimizing the content with those keywords, and enhancing elements such as title tags, meta descriptions, URL structures, content optimization, and image tagging to improve the website's understanding by search engines and increasing the website's authority through links from trustworthy and authoritative websites and designing a website compatible with mobile devices ensuring fast loading times and focusing on factors such as usability, navigability, and site speed to provide users with a better experience on the website (Das, 2021).

1.4. Search Engine Marketing

Search Engine Marketing (SEM) is a promotional technique that allows marketers to showcase their advertisements on search engine platforms. SEM typically targets advertisers who pay based on cost per click (CPC) or cost per thousand impressions (CPM). Google Ads stands as one of the most widely used platforms for SEM. It displays ads for specific keywords to gain quick access to potential customers. It targets ads to the desired audience based on demographic factors, geographical locations, and other specific parameters. It is increasing click-through rates and optimizing ad costs through well-optimized ad text, monitoring ad performance, tracking conversions, and analyzing the effectiveness of the ad strategy. Combining SEO and SEM can achieve effective results in digital marketing strategies. SEO increases organic search traffic and enhances the long-term authority of the website, while SEM provides instant visibility and targeted traffic. A good marketing strategy may require a balanced use of both methods (Panchal et al., 2021).

1.5. Social Media Marketing

Social media marketing entails leveraging social media channels to create brand awareness, engage with the target audience, drive traffic, and generate conversions. Social media enables companies to connect with prospective clients directly, establish and strengthen brand image, share content, and interact with customers. This entails devising a social media plan that is in sync with the business's goals, identifying the target audience, selecting platforms, planning content, managing interactions, producing valuable and engaging content, and sharing it on social media platforms. This content reflects the brand's values, informs the target audience, and encourages interaction. Social media channels enable companies to engage directly with potential customers. Businesses can strengthen customer relationships by responding to user comments, answering questions, and addressing customer complaints. Social media platforms serve as practical tools for advertising and promotions.

1.6. Influencer Marketing

Influencer marketing collaborates with influential personalities or influencers for brand or product promotion. Influencers are individuals who have a large following on social media or other digital platforms and have influence in a specific field. Influencer marketing enables influential personalities to interact with their followers, directly reach the target audience, build trust, and increase brand awareness. They identify influencers that align with the target audience and reflect the brand's values. Factors such as the influencer's follower base, engagement rate, level of influence, and content quality are considered. They collaborate with influencers to create content promoting the brand or products. This content should align with the influencer's natural style and be designed to resonate with the target audience.

Social media and influencer marketing offer businesses a broad reach, increased brand awareness, and the potential to drive customer conversions. These strategies play a significant role in engagement and digital marketing effectiveness. Social media is crucial in the realm of online marketing. Companies can connect with their desired consumers, elevate their brand image, and leverage influencer marketing on these digital platforms. Websites like Facebook, Instagram, and Twitter allow businesses to engage with their customer base, boost brand recognition, advertise their offerings, and attract prospective clients.

1.7. E-mail Marketing

E-mail marketing is an effective strategy in digital marketing. It aims to enable businesses to reach potential and existing customers directly, strengthen their relationships, and generate conversions. E-mail marketing allows businesses to reach potential and existing customers directly. Individuals can reach an e-mail list with their permission and deliver messages. Email marketing allows businesses to establish and strengthen relationships with potential and existing customers. Businesses can create customer loyalty and maintain customer relationships by sending valuable content, special offers, newsletters, etc., through e-mails. Email marketing is an effective strategy for increasing conversion rates. By promoting products or services by sending promotions, discounts, or special offers through e-mail, companies can expedite the conversion process for potential customers. E-mail marketing allows companies to segment and personalize their e-mail list. By sending automated e-mails such as welcome e-mails, auto-responses, and birthday greetings, companies can enhance the customer experience and manage timing more effectively. E-mail marketing involves using e-mail to send marketing messages to potential and existing customers. Automation, on the other hand, allows for the automatic sending of e-mails based on specific scenarios, which is an effective strategy in terms of personalization and timing.

1.8. Mobile Marketing

Mobile marketing is a critical element in online advertising, encompassing strategies to reach the target audience through mobile devices, increase brand awareness, encourage customer interaction, and achieve conversions. One of the initial steps to succeed in mobile marketing is to have a website compatible with mobile devices. Mobile users access companies' websites through smartphones or tablets. Therefore, a website must provide a mobile-optimized user experience, load quickly, and be user-friendly. Businesses can establish closer interaction with the target audience through mobile applications. Mobile apps can offer users special offers, personalized content, notifications, and other features that enhance the user experience. Being present in app stores and running app download campaigns are essential in mobile marketing. Short Message Service (SMS) marketing is a strategy of reaching customers through mobile devices by sending text messages. Companies can strengthen customer relationships and achieve conversions through messages such as special offers, discounts, event announcements, or customer reminders. However, paying attention to customer permissions and requirements in SMS marketing is essential. Another essential element of mobile marketing is location-based marketing. Mobile devices can track user location information, allowing them to offer location-specific content, discounts, or local events to the target audience. Location-based marketing can direct customers to physical stores or events and support

Mobile marketing is a vital strategy today, where users are constantly connected through their mobile devices. Businesses should effectively utilize mobile marketing strategies to improve the mobile user experience, increase interaction with the target audience, and achieve conversions.

Mobile marketing involves delivering marketing messages to the target audience through mobile devices. App development allows businesses to enhance the user experience and provide better customer service through mobile applications (Ström et al., 2014). Additionally, the effectiveness of mobile advertising strategies and the impact of mobile ads on consumer behavior are significant (Grewal, 2016). This marketing strategy aims to build the business's brand image and establish a positive positioning in the target audience's minds. Brand value, unique value proposition, and differentiation in the competition are essential elements.

1.9. Data-Driven Marketing

Data-driven marketing is an essential strategy in digital marketing that enables businesses to make more effective marketing decisions using data analytics and insights. Data-driven marketing offers the opportunity to develop strategies based on customer behavior, personalization, targeting, and measuring marketing performance. Here is a detailed description of data-driven marketing. The foundation of a data-driven marketing strategy is collecting and analyzing customer data. Gathering website traffic, social media interactions, email open rates, click-through rates, conversion data, etc., allows businesses to better understand their customers and marketing activities. This information offers a critical understanding of consumer actions, interests, and preferences.

2. The Usage of Artificial Intelligence in Marketing

Artificial intelligence encompasses various skills, including speech recognition, image identification, machine learning, and semantic search. AI is utilized to differentiate both sound and images (Panwar et al., 2021). Artificial intelligence profoundly influences the landscape of online marketing.. It makes digital marketing more efficient, effective, and scalable while enhancing user experience. However, ethics, privacy, and data security must be considered (Dumitriu & Popescu, 2020). Digital marketing and artificial intelligence have gained considerable momentum in recent years. The widespread use of the Internet and the popularity of digital platforms have provided companies with opportunities to reach their customers more effectively. Artificial intelligence holds great potential in complex data analytics, predictive analysis, and automated processes. Long-term relationships.

3. Machine Learning and Digital Marketing

Machine learning can offer personalized content and product recommendations based on users' past behaviors, preferences, and demographic characteristics. This enhances user experience and helps create a more effective marketing strategy. Furthermore, machine learning can help better understand potential customers and target specific segments more accurately.

3.1. Personalized Content and Recommendations

Machine learning algorithms can analyze a user's past interactions with a website or platform. The system can predict what content or products might interest them by considering their browsing history, purchase behavior, and preferences. This leads to highly personalized recommendations, enhancing user engagement and potentially driving more conversions.

3.2. Segmentation and Targeting

Machine learning can analyze vast amounts of customer data to identify distinct segments within the audience. These segments could be based on demographics, behaviors, or other criteria. Understanding these segments can tailor marketing messages to resonate more effectively with each group, leading to higher response rates.

3.3. Sentiment Analysis and Reputation Management

Sentiment analysis involves processing textual data (like social media posts or reviews) to determine the sentiment behind them – whether they are positive, negative, or neutral. Machine learning algorithms can automatically classify these sentiments, helping gauge how the public perceives a brand. This insight is invaluable for managing reputation and addressing customer concerns promptly

3.4. Search Engine Optimization with Machine Learning

Machine learning algorithms can analyze search engine algorithms and identify patterns related to high-ranking content. Understanding these patterns can optimize a website's content, meta tags, and other elements to improve search engine rankings and increase organic traffic.

3.5. Automation and Chatbots

Chatbots powered by machine learning can engage with customers in real time, answering their queries and providing assistance. These bots can use natural language processing to understand and respond to customer questions. They operate 24/7, enhancing customer support availability and saving valuable time for customers and the team.

3.6. Advertisement Optimization

Machine learning algorithms can analyze the performance of advertisements across various channels and platforms. Considering audience demographics, ad placement, and content, these algorithms can suggest adjustments to optimize ad campaigns for better reach, engagement, and conversion rates.

3.7. Analyzing Market Trends

Machine learning can process large datasets to identify patterns and trends in consumer behavior. Recognizing these trends early can adjust marketing strategies to align with emerging preferences, thus gaining a competitive advantage.

3.8. Customer Churn Analysis

Machine learning can predict which customers are at risk of churning (leaving business). By analyzing their past behaviors and comparing them to churned customers' behaviors, they can take proactive measures to retain these customers, such as targeted offers or personalized engagement efforts.

3.9. Product Pricing and Inventory Management

Machine learning can analyze market conditions, competitor pricing, and customer behavior to help determine optimal product prices. It can also predict demand patterns, allowing the management of inventory more efficiently and preventing stockouts or overstocking.

3.10. Competitive Analysis

Machine learning can crawl and analyze competitor websites, social media accounts, and marketing strategies. This analysis can provide insights into their strengths and weaknesses, helping them adjust their marketing efforts and gain a competitive edge. In essence, machine learning offers a data-driven marketing approach, enabling one to make more informed decisions, provide better user experiences, and allocate resources more effectively.

4. Methodology

This study aims to explain the trends and developments in the international literature concerning "Machine Learning" supported by artificial intelligence within digital marketing. The research employs bibliometric analysis, a quantitative research method, to accomplish this aim. Bibliometric analysis quantitatively evaluates publications produced by individuals or institutions within a specific field, time frame, and geographical area, examining the relationships among these publications. It can be considered a quantitative research methodology for content analysis and numerical analysis of documents

In line with the aim of the research, answers to the following questions have been sought: RQ1. What is the distribution of publication numbers of articles published on machine learning supported by artificial intelligence in the field of digital marketing by year?

RQ2. What is the distribution of journals where the most publications have been made on machine learning supported by artificial intelligence in digital marketing?

RQ3. How has the development been over the years for journals that guide publications related to machine learning supported by artificial intelligence in digital marketing?

RQ4. What is the distribution of the most-cited articles on machine learning supported by artificial intelligence in digital marketing?

RQ5. What is the frequency of using keywords in articles on machine learning supported by artificial intelligence in digital marketing?

RQ6. What is the distribution and relationship of the most frequently occurring words in the articles on machine learning supported by artificial intelligence in digital marketing? RQ7. Who are the most productive authors related to machine learning supported by artificial intelligence in the field of digital marketing, and what is the distribution of their publications by year?

RQ8. What are the countries that are most cited in articles prepared on machine learning supported by artificial intelligence in the field of digital marketing?

5. Conclusion and Discussion

Machine learning can more accurately analyze consumer behavior when used in digital marketing, making marketing strategies far more effective. Additionally, it can deeply examine user data to create personalized advertising campaigns, leading to higher conversion rates and increased customer satisfaction. Machine learning algorithms can automate customer service processes by creating Chabot's that instantly answer questions and resolve issues. Lastly, machine learning can measure the effectiveness of marketing campaigns in real time and provide instant feedback for continuous improvement.

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ANTIMICROBIAL FINISHING USING OLEANDER EXTRACT ON COTTON FABRIC

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ABSTRACT
A natural antimicrobial finishes has been prepared from natural extract for textile application. The natural bio-active agent such as oleander (NERIUM OLEANDER) extract of herbal product for antimicrobial finishes of textile substances. Herbal product from oleander has been applied to cotton fabric by the method of direct application in wet condition, the extract shows the antimicrobial activity. After investigation of COTTON TOWEL of antimicrobial finish has been used by the patients cold and the results have been observed that cold affect patient action is good on oleander.

INTRODUCTION
OLEANDER:

- Oleander scientific name is "NERIUM OLEANDER".
- Pronunciation: NEER-ee-um oh-lee-AN-der.
- Family: Apocynaceae.
- Nerium oleander has antimicrobial activity present.
- Oleander origin "Italy from the middle east".

ANTIMICROBIAL FINISHING:

- Antimicrobial finishes treatment can be applied to textile.
- They are used to variety of textile, including clothing, footwear, socks, underwear, bedding and towel.
- Antimicrobial finishing can be applied using physical or chemical method.
- There are two main types of antimicrobial finishing
- Temporary
- Durable

COTTON:

- Cotton is a soft, fluffy,hair-like fibre that comes from the cotton plant, a member of the mallow family.
- Cotton history: the Indus valley civilization began cultivating cotton around 3000 BCE.

METHODOLOGY

PREPARATION OF FABRIC
Fabric preparation improves wet ability of fabric thereby facilitates uniform finishing. Theaim of preparatory process is the first step towards quality, which removes the starch, naturalimpurities and natural yellowish gray coloring matter present in fabric and modifies the fabric forfollow up process. Pretreatmentof cotton fabriccontain primary, secondary impurities as showintablebelowandpurposeofdesizing andscouring istoremovetheseimpurities.

DESIZING

Desizing is done in order to remove the size from the warp yarns of the woven fabrics.Warp yarns are coated with sizing agents prior to weaving in order to reduce their frictionalproperties, decrease yarn breakages on the loom and improve weaving productivity by increasingweft insertion speeds. The sizing material present on the warp yarns can act as a resist towards dyes and chemicals in textilewetprocessing.Itmust, therefore, beremovedbeforeanysubsequentwetprocessingofthefabric.

SCOURING

The process of removing natural's oil, wax, fats, and gum etcas well as added impuritiesduring fabrication process to produce hydrophilic and clean textile materials is called scouring.Itisveryvitalprocessofwetprocessing.

BLEACHING

Bleaching, a process of whitening fabric by removal of natural colour, such as thetanof linen, isusuallycarriedout bymeansof chemicalsselectedaccording to thechemicalcompositionofthefibre.

COLLECTION OF PLANT MATERIAL

The plant of Arali leaf was collected from Sikkal .The plant was identified based on its morphological characteristics.

PREPARATIONOFPLANTPOWDER

The Nerium oleander leaf l were sun-dried. After drying at 37°C for 3 days the plant material was ground in a grinding machine made for the laboratory. Exposure to direct sunlight was avoided to prevent the loss of active components

NOMENCLATURE

S.NO	SAMPLE	NOMENCLATURE
1	NOE	NERIUM OLENDAR EXTRACT

EXTRACTION OF FINISHING FROM NERIUM OLENADER

The 100g powder samples were soaked with 1L methanol for 24 Hrs. The collected solution was concentrate upto high viscose stage. This extract used for dyeing cotton and cloth. 100 g of powdered plant material (leaves) of nerium oleander was filled in a thimble andextracted exhaustively by Soxhlet apparatus (8 h) using methanol at 60°C. The extract obtained was collected and passed through Whatmanno. 1 filter paper to remove all debrisan un extractable matter, including cellular materials and other constitutions that are insoluble in theextraction solvent. Filtered extract was concentrated usin g rotary evaporator at 40° C to obtaindry extractives.Methanolic extractwas dried for further investigation.

MATERIALS USED FOR FINISHING

Cloth accurately used for 33 neumonia was boiled in 1%of bleaching powder were weighted for 15 mins. The temperature was maintained at 60°C to remove starch from the fabric.Then washed with cold distilled water. The cloth was dried in sunlight. Cotton was dyed with separately plant leaves extract with and without mordant respectively.

ASSAY OF ANTIBACTERIAL ACTIVITY

Antibacterialactivitytestwascarriedoutfollowingthemodificationofthemethod originally described by Bauer et al., (1966). Muller Hinton agar was prepared and auto claved at 15 l bs pressure for 20 minutes and cooled to 45ºC. The cooled media was poured on to sterile petriplates and allowed for solidification. The plates with media were seeded with the respective microbial suspension using sterile swab. The various solvents extract prepared discs individually were placed on the each petriplates and also placed control and standard Ciprofloxacin(300µg) for Bacteria discs .The plates were incubated at 37ºC for 24 hrs. After incubation period, the diameter of the zone formed around the paper disc were measured and expressed in mm.

ANTIBACTERIALACTIVITY

S.No.	**Bacteria**	**ZoneofInhibition(mmindiameter)**		
		Control	**Standard***	**Sample 1**
1	**BacillusSubtilis**	**-**	**18**	**20**
2	**Escherichiacoli**	**-**	**20**	**22**
3	**Klebsiellapneumoniae**	**-**	**21**	**18**
4	**Staphylococcusaureus**	**-**	**17**	**19**

CONCLUSION

In this study, conclusion of this project is to give an antimicrobial finish to COTTON TOWEL finishing application on cotton fabric,to provide a medical textile for the person with cold affected .From the result of this thesis it is concluded that the leaves are having extreme antimicrobial potency against human pathogenic bacteria such as Bacillus Subtilis,Klebsiella pneumoniae, Escherichiacoli Staphyloc occusaureus.The cotton fabric was selected for the study,present impure the immunitiy power for cold affected paitent. After extracting the cotton fabric were processed equally by finishing with natural nerium oleander .The plant extract studied could be answer to the people seeking for better and no side effects.Inthe present study, neruim olendaer can effectively used for cold affected paitent .

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ANTIMICROBIAL FINISHING USING MANGIFERA INDICA EXTRACT ON COTTON FABRIC

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ABSTRACT

A natural antimicrobial finishes has been prepared from natural extract for textile application. The natural bio-active agent such as Mangifera Indica extract of herbal product for antimicrobial finishes of textile substances. Herbal product from Mangifera Indica has been applied to cotton fabric by the method of direct application in wet condition, the extract shows the antimicrobial activity. After investigation of COTTON FACE MASK of antimicrobial finish has been used by the patients cracked feet and the results have been observed that cracked heeling action is good on Mangifera Indica.

INTRODUCTION

Mangifera indica, commonly known as **mango**, is an evergreen species of flowering plant in the family Anacardiaceae. It is a large fruit tree, capable of growing to a height and width of 30 m (100 ft). There are two distinct genetic populations in modern mangoes – the "Indian type" and the "Southeast Asian type".

Antimicrobial finishes are treatments that can be applied to textiles to protect them from microbes and to protect the wearer from harmful germs. They are used on a variety of textiles, including clothing, footwear, socks, underwear, bedding, and towels**.**

Cotton is a soft, fluffy staple fibre that grows in a boll, or protective case, around the seeds of the cotton plants of the genus Gossypium in the mallow family Malvaceae. The fibre is almost pure cellulose, and can contain minor percentages of waxes, fats, pectins, and water. Under natural conditions, the cotton bolls will increase the dispersal of the seeds**.**

METHODOLOGY

PREPARATION OF FABRIC

Fabric preparation improves wet ability of fabric thereby facilitates uniform finishing. The aim of preparatory process is the first step towards quality, which removes the starch, natural impurities and natural yellowish gray coloring matter present in fabric and modifies the fabric for follow up process. Pretreatment of cotton fabric contain primary, secondary impurities as show in table below and purpose of desizing and scouring is to remove these impurities.

DESIZING

Desizing is done in order to remove the size from the warp yarns of the woven fabrics. Warp yarns are coated with sizing agents prior to weaving in order to reduce their frictional properties, decrease yarn breakages on the loom and improve weaving productivity by increasing weft insertion speeds. The sizing material present on the warp yarns can act as a resist towards dyes and chemicals in textilewetprocessing.It must, therefore be removed before any sub sequent wet processing of the fabric.

SCOURING

The process of removing naturals oil, wax, fats, gum etc as well as added impurities during fabrication process to produce hydrophilic and clean textile materials is called scouring .It is very vital process of wet processing.

BLEACHING

Bleaching, a process of whitening fabric by removal of natural colour, such as the tan of linen, is usually carried out by means of chemicals selected according to the chemical composition of the fiber.

COLLECTION OF PLANT MATERIAL

The plant of Mango leaf was collected from Thiruvarur. The plant was identified based on its morphological characteristics

PREPARATION OF PLANT POWDER

The Mangifera Indica leaf l were sun-dried. After drying at 37°C for 24 hrs the plant material was ground in a grinding machine made for the laboratory. Exposure to direct sunlight was avoided to prevent the loss of active components

NOMENCLATURE

S.NO	SAMPLE	NOMENCLATURE
1	INE	MANGIFERA INDICA EXTRACT

EXTRACTION OF FINISHING FROM INDIAN NETTLE

The 100g powder samples were soaked with 1Lmethanol for 24 Hrs. The collected solution was concentrate up to high viscose stage. This extract used for dyeing cotton and cloth.

100 g of powdered plant material (leaves) of Mangifera Indica. Was filled in a thimble and extracted exhaustively by Soxhlet apparatus (8 h) using methanol at 60°C. The extract obtained was collected and passed through What man no. 1 filter paper to remove all debris an un extractable matter, including cellular materials and other constitutions that are insoluble in the extraction solvent. Filtered extract was concentrated using rotary evaporator at 40° C to obtain dry extractives. Methanolic extract was dried for further investigation.

MATERIAL USED FOR FINISHING

Cloth accurately used for 33 neumonia was boiled in 1%of bleaching powder were weighted for 15 mins. The temperature was maintained at 60°C to remove starch from the fabric. Then washed with cold distilled water. The cloth was dried in sunlight. Cotton was dyed with separately plant leaves extract with and without mordant respectively.

Antibacterial activity test was carried out following the modification of the method originally described by Bauer et al., (1966). Muller Hinton agar was prepared and autoclaved at 15 lbs pressure for 20 minutes and cooled to 45ºC. The cooled media was poured on to sterile Petri plates and allowed for solidification. The plates with media were seeded with the respective microbial suspension using sterile swab. The various solvents extract prepared discs individually were placed on the each Petri plates and also placed control and standard Ciprofloxacin (300µg) for Bacteria discs. The plates were incubated at 37ºC for 24 hrs. After incubation period, the diameter of the zone formed around the paper disc were measured and expressed in mm.

S.No.	Bacteria	ZoneofInhibition(mmindiameter)		
		Contro l	Standard*	Sample 1
1	BacillusSubtilis	-	18	20
2	Escherichiacoli	-	20	22
3	Klebsiellapneumoniae	-	21	18
4	Staphylococcusaureus	-	17	19

CONCULSION

In this study, conclusion of this project is to give an antimicrobial finish to face mask finishing application on cotton fabric, to provide a medical textile for the person with pain reduce for soreness. From the result of this thesis it is concluded that the Mangifera Indica leaves are having extreme antimicrobial potency against human pathogenic bacteria such as Bacillus Subtilis, Klebsiellapneumoniae, Escherichia coli, and Staphylococcus aureus. The cotton fabric was selected for the study, present moisture and absorbency, softness for feet. After extracting the cotton fabric were processed equally by finishing with natural Mangifera Indica. The plant extract studied could be answer to the people seeking for better and no side effects. In the present study, Mangifera Indica. can effectively used for healing of pain reduce for soreness.

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DEVELOPMENT OF SMART UNIFORMS FOR EMERGENCY SERVICES

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ABSTRACT

The advancement of wearable technology has paved the way for the development of "smart" uniforms, particularly in high-stakes sectors like emergency services. Smart uniforms, integrating sensors and real-time data analytics, can provide critical support for first responders such as firefighters, paramedics, and police officers. This paper explores the potential benefits, challenges, and technological considerations in the development of smart uniforms for emergency services. The integration of wearable technology can enhance situational awareness, monitor vital signs, improve safety, and optimize response efficiency. The paper also outlines the current state of research and development, potential applications, and future directions for smart uniforms in emergency services.

Keywords: Smart uniforms, emergency services, wearable technology, first responders, situational awareness, safety, vital signs monitoring.

Introduction

Emergency services personnel operate in hazardous environments where the timely and accurate provision of information can save lives. The integration of wearable technologies into their uniforms offers a transformative approach to improving operational safety and efficiency. A smart uniform is equipped with various sensors and communication tools, allowing real-time monitoring of physiological data, environmental factors, and location tracking. These advancements promise to enhance both the response capabilities and safety of emergency personnel during critical operations.

This paper discusses the design, development, and implementation of smart uniforms, particularly for firefighters, paramedics, and police officers. It examines how integrating technologies such as bio-sensing devices, GPS, body temperature regulation systems, and real-time communication can optimize the work environment for emergency responders.

1. Background and Motivation

The concept of wearable technology is not new, but its application in emergency services is still emerging. Traditional uniforms offer limited functionality, primarily providing protection from external environmental factors (e.g., fire-resistant clothing for firefighters or bulletproof vests for law enforcement). However, the complexity and unpredictability of emergency situations demand more dynamic and interactive solutions. Smart uniforms can address these needs by providing real-time information on the wearer’s condition and surroundings, allowing better decision-making and more efficient resource allocation.

Previous studies have demonstrated the potential of wearable technologies in monitoring first responders' health metrics such as heart rate, temperature, and stress levels (Ferrer et al., 2020). Moreover, integrating real-time communication systems can streamline coordination among teams during emergencies (Parker et al., 2021). These advancements help reduce response time and mitigate risks to responders' health.

2. Technological Features of Smart Uniforms

2.1. Sensors for Health Monitoring

A key feature of smart uniforms is the integration of various sensors that can continuously monitor the wearer's vital signs, such as heart rate, blood pressure, body temperature, and oxygen levels. Wearable biosensors are designed to detect physiological distress or environmental hazards such as heatstroke or fatigue, which can trigger automatic alerts for both the wearer and a centralized command center. Research has shown that monitoring health data in real-time can significantly improve responder safety (Chung et al., 2022).

2.2. Environmental Sensors

Smart uniforms can also include environmental sensors that measure temperature, humidity, air quality, and toxic gases, all critical factors in hazardous environments like fires or chemical spills. These sensors can provide critical feedback to emergency services, ensuring that responders are aware of potential hazards that could compromise their safety (Feng et al., 2023).

2.3. GPS and Location Tracking

Tracking the location of responders in real time is crucial in large-scale disaster management or urban emergencies. Smart uniforms can incorporate GPS technology to ensure that responders are accounted for, preventing disorientation in unfamiliar or dangerous terrains. Geolocation data can also help in optimizing rescue routes and managing resources more efficiently (Baker et al., 2021).

2.4. Communication Systems

A reliable communication network is vital for effective collaboration among emergency responders. Smart uniforms can feature integrated communication systems, allowing for voice and data exchange, even in areas with poor network coverage. This functionality is particularly important in disaster scenarios where coordination and timely communication are essential for saving lives (Zhao et al., 2022).

2.5. Energy Efficiency and Power Supply

An essential challenge in the development of smart uniforms is ensuring a reliable power supply for all embedded sensors and devices. Energy-efficient solutions such as flexible batteries or energy harvesting systems (e.g., using motion or body heat to generate power) are being explored to ensure continuous operation of the smart uniform without frequent recharging (Yang et al., 2024).

3. Benefits of Smart Uniforms for Emergency Services

3.1. Enhanced Safety

The primary benefit of smart uniforms lies in enhancing the safety of emergency responders. The ability to monitor vital signs and environmental conditions in real time allows for early detection of distress signals such as elevated heart rates or exposure to toxic substances. These alerts can trigger immediate intervention from medical teams or safety personnel, thereby reducing the risk of injury or death.

3.2. Improved Situational Awareness

Smart uniforms can provide responders with contextual information about their environment, such as temperature readings, air quality, or the location of other team members. This data helps improve decision-making by offering a comprehensive view of the situation. Additionally, real-time alerts about potential dangers enable responders to adjust their strategies to mitigate risks (Parker et al., 2021).

3.3. Increased Operational Efficiency

By integrating location tracking and communication tools, smart uniforms allow for better coordination during large-scale operations. Rescue teams can quickly be dispatched to the most critical locations, and resources can be optimized based on real-time data. This results in faster response times and more effective disaster management.

3.4. Data Collection and Post-Operation Analysis

The continuous collection of data from smart uniforms provides valuable insights that can be used for post-operation analysis. Data analytics can help evaluate responder performance, identify areas for improvement, and inform future training or equipment upgrades.

4. Challenges and Considerations

4.1. Privacy and Data Security

The continuous monitoring of physiological and environmental data raises concerns about the privacy and security of responders. Implementing secure communication channels and ensuring data anonymization are critical to addressing these concerns (Zhao et al., 2022).

4.2. Comfort and Wearability

Smart uniforms must strike a balance between functionality and comfort. The integration of sensors, communication devices, and power supplies should not compromise the wearer's mobility or comfort. Lightweight, flexible, and breathable materials are essential for ensuring that the uniform can be worn for extended periods without causing discomfort.

4.3. Cost and Accessibility

The cost of developing and deploying smart uniforms could be prohibitive for many emergency services, particularly in resource-limited settings. A cost-effective approach that includes scalability and modularity could help make these technologies more accessible (Yang et al., 2024).

5. Future Directions

Future research and development in smart uniforms should focus on improving sensor accuracy, enhancing battery life, and exploring new materials for increased comfort and durability. Additionally, advancements in artificial intelligence and machine learning could further enhance the predictive capabilities of smart uniforms, allowing for proactive interventions based on data trends. Collaborative efforts among technology developers, emergency services, and regulatory bodies will be crucial in ensuring the widespread adoption and effectiveness of smart uniforms.

CONCLUSION

Smart uniforms for emergency services represent a promising frontier in the enhancement of responder safety and operational efficiency. By leveraging wearable technologies, smart uniforms can provide real-time health monitoring, environmental sensing, and communication tools that improve situational awareness and response times. Despite the challenges of integration, cost, and privacy concerns, the development of smart uniforms offers substantial benefits that could revolutionize emergency response operations, making them safer, more effective, and more efficient.

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AI IN FASHION TREND FORCASTING

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ABSTRACT

The fashion industry is one of the most dynamic and rapidly changing industries in the world. Fashion trend forecasting is a crucial aspect of the industry, as it helps fashion brands and retailers to stay ahead of the curve and remain competitive. Traditional methods of fashion forecasting rely on human intuition, experience, and manual analysis of historical data. However, with the advent of Artificial Intelligence (AI), fashion trend forecasting has become more accurate, efficient, and data-driven. This paper reviews the current state of AI in fashion trend forecasting, including the types of AI algorithms used, the benefits and challenges of AI-powered trend forecasting, and the future direction of the field.

Keywords: Artificial Intelligence, Fashion Trend Forcasting, Machine Learning, Deep Learning, Natural Language Processing, Predictive Analystics, Fashion Industry, Fashion Brands, Fashion Retailers.

INTRODUCTION

Fashion trend forecasting is a crucial aspect of the industry, as it helps brands and Retailers to anticipate and prepare for upcoming trends, ensuring that they are always in style and in demand. However, traditional methods of fashion trends forecasting have several limitations. They are often subjective, relying on the intuition and experience of individual forecasters, and can be time-consuming and labour-intensive. Moreover, the sheer volume of data available in the fashion industry, from social media and fashion shows to consumer behavior and sales data, can be overwhelming, making it difficult for forecasters to identify patterns and trends.

Current State of AI in Fashion Trend Forecasting

AI-powered trend forecasting uses machine learning and deep learning algorithms to analyze large amounts of data from various sources, including social media, fashion show, and consumer behavior. The benefits of AI-powered trend forecasting include improved accuracy and reliability, increased efficiency and speed, and enhanced creativity and innovation. However , there are also challenges and limitations to AI-powered trend forecasting , including data quality and availability, interpretation and analysis of AI outputs, bias and errors in AI algorithms, and cost investment required for AI implementation.

Benefits of AI IN Fashion Trend Forecasting

The benefits of AI in fashion trend forecasting are numerous and significant. One of the primary advantages of AI in this field is its ability to analyze large amounts of data from various sources, including social media, fashion shows, and consumer behavior, to provide accurate and reliable trend forecasts. This enables fashion brands and retailers stay ahead of the curve and anticipate emerging trends, allowing, them to make informed decisions about their design, production, and marketing strategies. Additionally, AI can help fashion designers and brands to identify new and innovative trends, and to develop unique and creative designs that meet the changing needs of consumers.

The benefits of AI in fashion trend forecasting include:

- Improved accuracy and reliability of trend forecasts
- Increased efficiency and speed of trend forecasting
- Enhanced creativity and innovation in fashion design
- Better decision making and reduced risk in fashion production and distribution.

Challenges and Limitations of AI in Fashion Trend Forecasting

The integration of AI in fashion trend forecasting is not without its challenges and limitations. One of the primary concerns is the quality of availability of data, as AI algorithms require large amounts of accurate and relevant data to provide reliable predications. Additional, the fashion industry is inherently subjective, and AI systems may struggle to fully understand the nuances of human taste and creativity. Furthermore, AI-powered trend forecasting system can be biased towards certain style or trends, and may not always be able to identify emerging trends or patterns. Another limitation is the lack of transparency in AI decision-making processes, making it difficult to understand why certain predictions or recommendations are made. Moreover, the use of AI in fashion trend forecasting is also raises concerns about job displacement, as automated systems may replace human forecasters and designer.

The challenges and limitations of AI in Fashion Trend Forecasting include:

- Data quality and availability
- Interpretation and analysis of AI outputs
- Bias and errors in AI algorithms
- Cost and investment required for AI implementation

AI-powered Fashion Trend Forecasting

The use of AI in fashion trend forecasting also enables the creation of personalized trend forecasts, which can be tailored to specific brands, retailers, or consumer segments. For example, an AI-powered trend forecasting system can analyze a brand's historical sales data, customer demographics, and social media engagement to provide a personalized trend forecast that highlights the most relevant and profitable trends for that brand. This can help brands and retailers to optimize their product lines, marketing campaigns, and supply chain management to better meet the needs of their target audience. Moreover, AI-powered trend forecasting can also facilitate collaboration between different teams and stakeholders in the fashion industry, including designers, buyers, and marketers, by providing a shared understanding of trends and consumer preferences. By leveraging AI-powered fashion trend forecasting, brands and retailers can gain a competitive advantage in the market, improve their trend forecasting accuracy, and drive business success.

The integration of AI in fashion trend forecasting is also driving innovation in the industry, with the development of new technologies and platforms that enable more accurate and efficient trend forecasting. For instance, some AI-powered trend forecasting platforms use computer vision to analyze images and videos from fashion shows, social media, and other sources to identify trends and patterns. Others use natural language processing to analyze text data from social media, fashion blogs, and other sources to identify emerging trends and sentiment. These technologies have the potential to revolutionize the fashion industry, enabling brands and retailers to respond more quickly and effectively to changing consumer preferences and trends.

1. Overview of AI-powered trend forecasting methods
2. Types of AI algorithms used in trend forecasting, including:
    - Machine learning
    - Deep learning
    - Natural language processing

Examples of AI-powered trend forecasting tools and platforms, including:

- Predictive analytics software
- Social media monitoring tools
- Fashion trend forecasting platforms

Application of AI in Fashion Trend Forecasting:

The application of AI in fashion trend forecasting is a rapidly growing field, with numerous potential uses and benefits. One of the primary applications of AI in fashion trend forecasting is in the analysis of social media data, where AI algorithms can be used to identify emerging trends and patterns in consumer behavior. For example, AI-powered systems can analyze social media platforms such as Instagram and Twitter to identify popular fashion items, colors, and styles, and provide insights into consumer preferences and trends. Additionally, AI can be used to analyze data from fashion shows, trade events, and other industry sources to identify emerging trends and predict future fashion directions. Another application of AI in fashion trend forecasting is in the development of predictive analytics models, which can be used to forecast future sales and demand for specific fashion items. Thesemodels can be based on historical data, seasonal fluctuations, and other factors, and can provide fashion brands and retailerswith valuable insights into future market trends.

Case Studies of AI in Fashion Trend Forecasting:

1. Stitch Fix: Stitch Fix uses AI to personalize fashion recommendations for its customers. The company's AI algorithm analyzes data on customer preferences, behavior, and body type to recommend clothing items that are likely to fit and appeal to each individual customer.
2. Zara: Zara uses AI to analyze data on customer behavior, sales, and inventory levels to predict future demand for specific clothing items. The company's AI system uses machine learning algorithms to analyze data from various sources, including social media, customer reviews, and sales data.
3. H&M: H&M uses AI to analyze data on customer behavior, sales, and inventory levels to predict future demand for specific clothing items. The company's AI system uses machine learning algorithms to analyze data from various sources, including social media, customer reviews, and sales data.
4. ASOS: ASOS uses AI to personalize fashion recommendations for its customers. The company's AI algorithm analyzes data on customer preferences, behavior, and body type to recommend clothing items that are likely to fit and appeal to each individual customer.

Future of AI in Fashion Trend Forecasting:

The future of AI in fashion trend forecasting is exciting and rapidly evolving. As AI technology continues to advance, we can expect to see even more innovative applications of AI in the fashion industry. One potential development is the increased use of computer vision and machine learning algorithms to analyze images and videos from fashion shows, social media, and other sources to identify trends and patterns. This could enable fashion brands and retailers to respond more quickly and effectively to changing consumer preferences and trends. Additionally, the use of natural language processing and sentiment analysis could become more prevalent, allowing fashion brands and retailers to better understand consumer opinions and preferences. Furthermore, the integration of AI with other technologies such as augmented reality and virtual reality could enable new and innovative ways of experiencing and interacting with fashion, such as virtual try-on and immersive brand experiences.

Another potential development is the increased use of predictive analytics and forecasting models to predict future fashion trends and demand. This could enable fashion brands and retailers to make more informed decisions about production, inventory, and pricing, and to reduce waste and excess stock. Moreover, the use of AI-powered trend forecasting could enable fashion brands and retailers to identify emerging trends and patterns more quickly, and to respond more effectively to changing consumer preferences. This could be particularly important in the fast-fashion industry, where speed and agility are critical to success. Furthermore, the use of AI-powered trend forecasting could also enable fashion brands and retailers to create more personalized and targeted marketing campaigns, based on individual consumer preferences and behaviors.

The future of AI in fashion trend forecasting also holds potential for increased sustainability and reduced waste. By using AI to analyze consumer behavior and preferences, fashion brands and retailers could create more targeted and effective marketing campaigns, reducing the need for excess stock and waste.

CONCLUSION:

In conclusion, AI has the potential to revolutionize fashion trend forecasting by providing accurate, efficient, and data-driven insights. While there are challenges and limitations to AI-powered trend forecasting, the benefits are significant, and the future of the field is exciting and promising.

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SCRUTINY OF ANALGESIC AND ANTI-INFLAMATORY FINISH IN EYE MASK USING HYDROPHYTES COLOCASIA ESCULENTA PHYLLO

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ABSTRACT

An eco-friendly natural analgesic and anti-inflammatory finish has been prepared from the plant extracts for textile application. Herbal extract from Colocasia esculenta phyllo have been applied to the cotton by the method of direct application of extracts in wet condition which has been made into eye mask. The extract demonstrated the strongest astringent activity. The eye-mask after enhancing with anti-inflammatory finish has been used to the person having eye disease such as cataracts and myopia and the result have been observed positively.

INTRODUCTION

TEXTILES

A textile or cloth is a flexible material consisting of natural or artificial fibres often referred to as thread or yarn. Yarn is produced by spinning raw fibres of wool, flax, cotton, or other material to produce long strands. Textile are produced by weaving, knitting, chrocheting, knotting or pressing fibre together. Cloth may be used synonymously with fabric used for a specific purpose.

Technical textile includes textile for medical textiles, geo textile, agro textile and protective clothing.

HEALTH CARE TEXTILE

Eye-mask is made from very smooth high quality dyed fabric. This will make you feel very relaxed and fresh and helps you to sleep well. Sleep masks made from fabric that will essentially block out any light so you are in total darkness, so your sleep becomes more undisturbed and regular. They have comfortable bands that stretch around your head. Sleep mask can help dry eyes. While they do not specially help with moisture retention they can stop the flow from outside air pressure such as air –conditioning. Eye mask is used to soothe tired eyes while blocking out distracting light to help you rest and relax. Place over your eyes from eye diseases. The most popular light weight material used in sleep-mask is breathable cotton, silk and silk blends, foam polymers and poly beads are used often in various product labelled as a sleep mask to fit your various needs.

SALIENT FEATURES

Sizes available –length (17.5cm) & width (7.5cm)

Application - For protecting eyes

COLOCASIA ESCULENTA PHYLLO

It is commonly known as Taro plant which grows wild even in the cities. It is scientific name is Colocasia esculenta phyllo .It is a common emergent aquatic weed in Indian gardens and waste places throughout the plains of India. The leaf which are shaped like a large ear or shield. Taro leaves are medium to large size and broad and heart shaped, averaging up to 40cm in length and 20cm in width. The leaves are dark green and smooth on the surface and light green on the underside. The underside of the leaves also veins that branch out from the central stem.

MEDICINAL PROPERTIES

It has anti-inflammatory and analgesic properties. It contains vitamin A, vitamin B and vitamin C. The juice of the taro leaf is considered to be stimulant, astiregent and appetizes.

USES

1. Act as an anti-oxidant to prevent cancer.
2. Boosts your immune system.
3. Keep your eyes healthy.
4. Reduce cholesterol level.
5. Helps controls blood pressure.
6. Helps prevent anaemia.
7. Help reduce wrinkle skin.

OBJECTIVES

1. To improve the analgesic recovery by herbal treated eye-mask.
2. To study the anti-inflammatory effect from the colocasia esculents phyllo exracts.
3. To study the anti-inflammatory agent for controlling the eye diseases.
4. To prevent the eye from infections like dryness of eyes, inflammation, cataracts and myopia
5. To improve eye-vision activity by the help of herbal treated eye-mask.

METHODOLOGY
COLLECION OF PLANT SAMPLES

The fresh leaves of colocasia esculenta phyllo were collected from the aquatic areas of Thanjavur.

EXTRACTION OF LEAVES SAMPLES

These partially dried plants samples of COLOCASIA ESCULENTA PHYLLO were collecting and mixed with distilled water, this residue was boiled in a hot water at boiling temperature 100 degree celcius.

ANTI INFLAMATORY ACTIVITY
MICRO ORGANISM
COLLECION OF TEST BACTERIA

The Bacterial strains of Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae and Bacillus subtilis was obtained from Microbial Type culture Collection Centre (MTCC), Chandigarh.

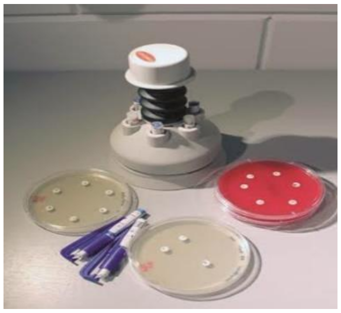
Table – 1

ASSAY OF ANTIBACTERIAL ACTIVITY IN COTTON SAMPLE

S. No.	Bacteria Name	Zone of Inhibition (diameter in mm)		
		Control	Standard*	Sample
1	Escherichia coli	-	16	21
2	Klebsiella pneumoniae	-	15	19
3	Staphylococcus aureus	-	20	22
4	Bacillus subtilis	-	21	28

*NIT-Nitrofurantoin (300µg).

INNOCULUM PREPARATION



ETHANOL

Ethanol is one of the most commonly used chemical for withstand the finishing on cotton at room temperature.

After adding the powdered dry ingredient into the 1000ml of distilled water and it allows to dissolve completely for 20 minutes.

TREATMENT FOR PERSONS WITH ANTI-INFLAMMATORY FINISH ON EYE MASK

The eye mask was used to the person who was suffered from an external eye infections and the result were observed. Totally five persons were wearing a mask and under the observation.

ANTI INFLAMMATORY FINISHED EYE MASK

OBSERVATION OF PERSONS USED ANTI INFLAMMATORY FINISHED EYE MASK

- The colocasia esculenta phyllo (cheppa kilangu ilai) had high astringent activity that helps to healing the eye infections quickly
- When wearing the eye mask, cotton gives natural cooling properties and its helps to sleep quickly also reduce the dark circles, inflammation and other external eye infections.
- This eye mask is effectively improves the skin around the eyes and the anti-inflammatory activity prevents the eye diseases.

RESULT AND DISCUSSION

SIZE OF THE EYE MASK

Fabric size of eye mask samples are presented in the table -1 and figure-1.

TABLE-1:

LENGTH OF CLOTH	WIDTH OF CLOTH	TOTAL SIZE
17.5cm	7.5cm	17.cm*7.5cm

MANUFACTURING DATE	EXPIRED DATE
DECEMBER 2019	MARCH 2020

From the table-1shows the size of the eye mask in length 17.5cm and the width is 7.5cm.

BEFORE AND AFTER FINISHING WEIGHT OF THE ANTI-INFLAMMATORY EYE MASK

Fabric weight of the eye mask before and the after finish of anti-inflammatory samples is presented in the table-2 and figure-2.

TABLE-2:

WEIGHT OF THE ORDINARY EYE MASK IN GRAMS	WEIGHT OF THE ANTI-INFLAMMATORY ACTIVITY EYE MASK IN GRAMS
21.103 grams	21.503 grams

From the table-2, the weight of the ordinary eye mask is 21.103grams and the weight of the anti-inflammatory activity eye mask is 21.503grams.

QUANTITY OF COLOCASIA ESCULENTA PHYLLO USED

The quantity of the herbal product used in the table-3 is showed.

HERBAL NAME	WEIGHT IN GRAM
COLOCASIA ESCULENTA PHYLLO	100grams

From the table-3, the quantity of the herbal product colocasia esculenta phyllo is 100grams.

ANTI- INFLAMMATORY ASSAY

DISC PREPARATION

The 6mm (diameter) discs were prepared from Whatmann No. 1 filter paper. The discs were sterilized by autoclave at 121°C.After the sterilization the moisture discs were dried on hot air oven at 50°C.Then various solvent extract discs and control discs were prepared.

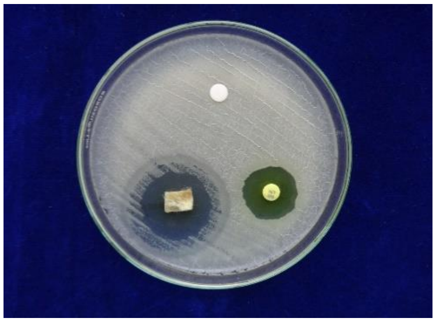
COLLECTION OF TEST BACTERIA

The Bacterial strains of Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae and Bacillus subtilis was obtained from Microbial Type culture Collection Centre (MTCC), Chandigarh.

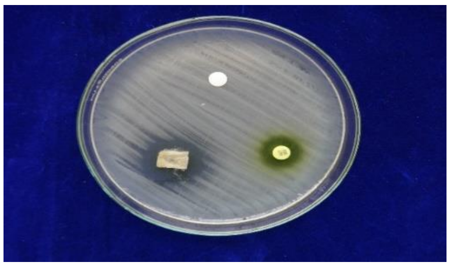
ASSAY OF ANTI INFLAMMATORY ACTIVITY

Antibacterial activity test was carried out following the modification of the method originally described by Bauer et al., (1966). Muller Hinton agar was prepared and autoclaved at 15 lbs pressure for 20 minutes and cooled to 45ºC. The cooled media was poured on to sterile petriplates and allowed for solidification. The plates with media were seeded with the respective microbial suspension using sterile swab. The various solvents extract prepared discs individually were placed on the each petriplates and also placed control and standard (Nitrofurantoin (300 µg) for Bacteria) discs. The plates were incubated at 37ºC for 24 hrs. After incubation period, the diameter of the zone formed around the paper disc were measured and expressed in mm.

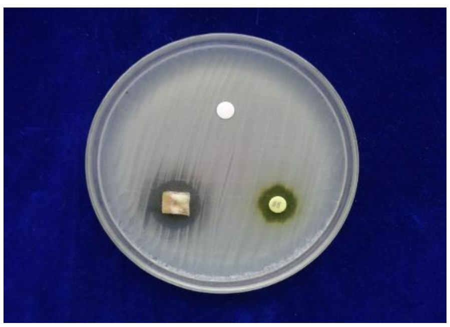
DISC-1 (ESCHERICHIA COLI-21mm)



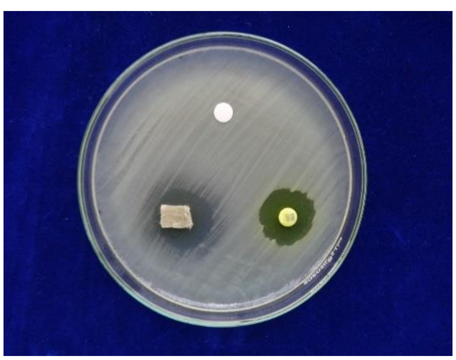
DISC-2(KLEBSIELLA PNEUMONIAE-19mm)



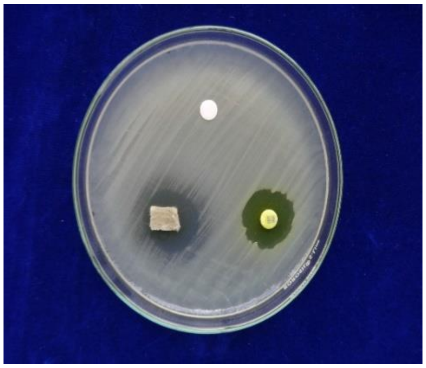
DISC-3(STAPHYLOCOCCUS AUREUS-22mm)



DIC-4(BACILLUS SUBTILIS-28mm)



DISC-5



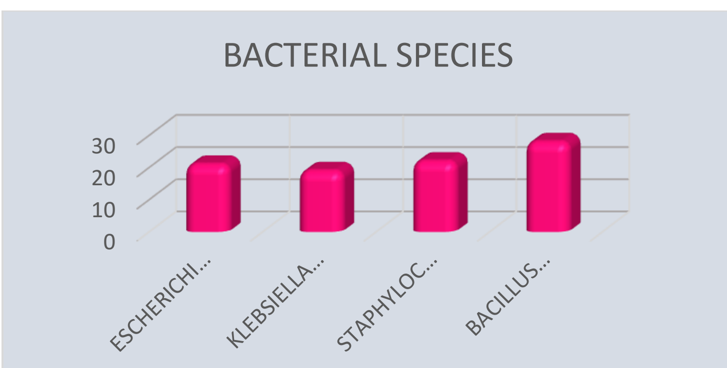
TYPES OF BACTERIA

S. No.	Bacteria Name	Zone of Inhibition (diameter in mm)		
		Control	Standard*	Sample
1	Escherichia coli	-	16	21
2	Klebsiella pneumoniae	-	15	19
3	Staphylococcus aureus	-	20	22
4	Bacillus subtilis	-	21	28

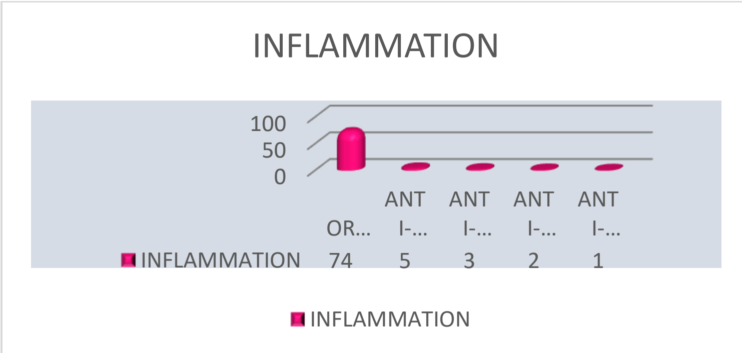
*NIT-Nitrofurantoin (300µg).

From the table, shows the types of bacteria.

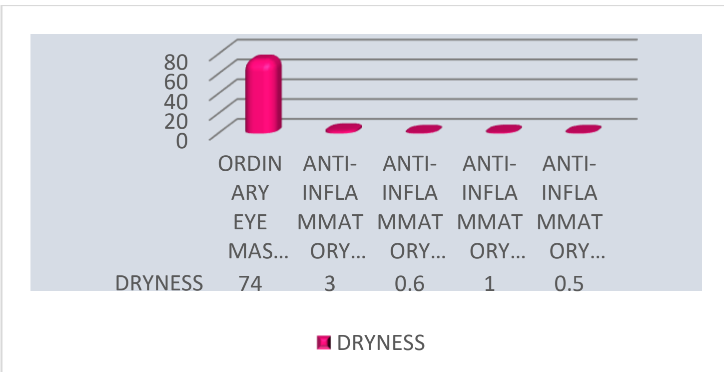
FIGURE: SIZE OF THE ZONE OF BACTERIAL SPECIES (ESCHERICHIA COLI, KLEBSIELLA PNEUMONIAE, STAPHYLOCOCCUS AUREUS, BACILLUS SUBTILIS)



APPERANCE OF INFLAMMATION



APPERANCE OF DRYNESS



EXPERIMENTAL PROCEDURE

The fresh leaves of colocasia esculenta phyllo were collected from the aquatic areas of Thanjavur. These partially dried plants samples of colocasia esculenta phyllo were collected and mixed with distilled water, this residue was boiled in a hot water at boiling temperature 100 degree celcius.

ASSAY OF ANTIBACTERIAL ACTIVITY IN COTTON SAMPLE

S. No.	**Bacteria Name**	**Zone of Inhibition (diameter in mm)**		
		Control	**Standard***	**Sample**
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3	Staphylococcus aureus	-	20	22
4	Bacillus subtilis	-	21	28

*NIT-Nitrofurantoin (300µg).

INNOCULUM PREPARATION

To this nutrient broth, inoculate the bacterial culture with of the help of loop and kept in a shaker for 12 to 16 hours at 36C.

ANTI-INFLAMMATORY EYE MASK FINISH TEST

Disc diffusion method was adopted to study the anti-inflammatory activity of plant extracts. Eye mask disc (21mm in diameter) was used. Disc were stored at 5C prior to use. Tests were performed by impregnating discs with colocasia esculenta phyllo plated on agar and incubated at 40C for 8 hours. Anti-inflammatory activities were then measured and indicated by the clear zone of inhibition.

After finished anti-inflammatory activity on eye mask is ready for use (inflammatory and dryness areas) without any English medicine.

OBSERVATION OF PERSON USED ANTI-INFLAMMATORY FINISHED EYE MASK

- The colocasia esculenta phyllo (cheppa kilangu ilai) had high astringent activity that helps to healing the eye infections quickly
- When wearing the eye mask, cotton gives natural cooling properties and its helps to sleep quickly also reduce the dark circles, inflammation and other external eye infections.
- This eye mask is effectively improves the skin around the eyes and the anti-inflammatory activity prevents the eye diseases.

SUMMARY & CONCLUSION

A textile or cloth is a flexible material consisting of natural or artificial fibres often referred to as thread or yarn. Yarn is produced by spinning raw fibres of wool, flax, cotton, or other material to produce long strands. Textile are produced by weaving, knitting, chrocheting, knotting or pressing fibre together. Cloth may be used synonymously with fabric used for a specific purpose.

The most used plant fibres are cotton, flax and hemp, although sisal, jute, kenaf, bamboo and coconut are also widely used. Plant fibre is composed mainly of cellulose and cellulose fibres are most commonly used to make paper and cloth

Eye-mask is made from very smooth high quality dyed fabric. This will make you feel very relaxed and fresh and helps you to sleep well. Sleep masks made from fabric that will essentially block out any light so you are in total darkness, so your sleep becomes more undisturbed and regular. They have comfortable bands that stretch around your head. Sleep mask can help dry eyes. While they do not specially help with moisture retention they can stop the flow from outside air pressure such as air –conditioning. Eye mask is used to soothe tired eyes while blocking out distracting light to help you rest and relax. Place over your eyes from eye diseases. The most popular light weight material used in sleep-mask is breathable cotton.

In order to impart the required functional properties to the fibre or fabric, it is customary to subject the material to different types of physical and chemical treatments. For example, wash and wear finish for a cotton fabric is necessary to make it crease-free or wrinkle free. In a similar way, mercerising, singeing, flame retardant, water repellent, waterproof, anti-static and peach finishing achieve various fabric properties desired by consumers.

Assessment of anti-inflammatory activity finishes on textile material is determined by the degree of anti-inflammatory activity intended in the use of such materials. If only bacteriostatic activity (inhibition of multiplication) is intended, a qualitative procedure which clearly demonstrates anti-inflammatory activity as contrasted with lack of such activity by an untreated specimen may be acceptable. Effect of ethanol extract of the leaves of colocasia esculenta phyllo was investigated against inflammation and dryness. The medicinal property of this plant has been known to siddha medicine where it is called cheppa kilangu and it is used in the portions for skin care.

This herb has been used since ancient times in Hindu and Ayurvedic traditional medicine. This is an aquatic plant and grows well on moisture temperature or aquatic areas. Therefore scientific method must be resorted to identify and maintain quality of drugs to be used in the traditional system of medicine. In this present study medicinally important drug P.ambonicus is studied from micro morphological point of view. Thus the project successfully brings about the thorough analysis, methodology, procedures on experimenting a fabric (eye mask) with anti-inflammatory finish which is effective against the inflammation and dryness which cause bacterial infections on eyes.

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COMPARISON AND DEVELOPMENT OF THERMAL PROPERTIES OF BAMBOO-COTTON AND MODAL-COTTON KNITTED FABRICS FOR SPORTSWEAR

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Head & Assistant Professor, Department of Fashion and Technology and Costume Designing,
Bon Secures College for Women (Autonomous) Thanjavur.

ABSTRACT:

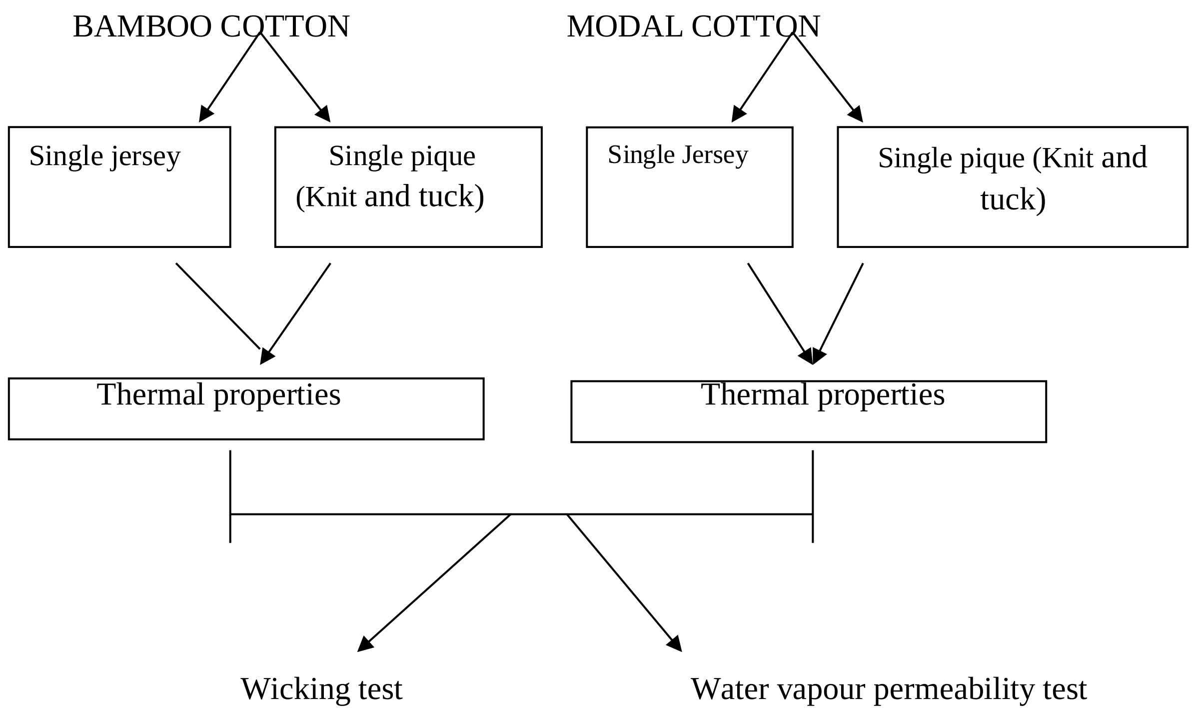
A knitted fabric consist of forming yarn(s) into loops, each of which is typically only released after a succeeding loop has been formed and intermeshed with it so that a secure ground loop structure is achieved. In the knitted fabric, bamboo and Modal were different loop structure (single jersey,). These fabrics are subjected to the testing, wicking test, water vapour permeability. Bamboo Knit Fabric is naturally bacteria and odor resistant, and is the practical, yet eco-friendly choice. True to a natural fiber, bamboo knits are already absorbent and breathable. The thermal conductivity of the fabrics was generally found to decrease with increase in the proportion of Modal fibre. The water vapour permeability and wicking of the fabrics were observed to increase with increase in Modal fibre content. The strength of bamboo adds to the durability of the fabric and is found to work well. These Bamboo fibers possess all the characteristics and thermal properties bamboo cotton then the compare Modal cotton.
Keyword: bamboo, Modal, thermal Properties

INTRODUCTION

It is in recent times, the sight on sports has changed from allowing for it as leisure or an extracurricular activity to a vital part of day to day routine / activity. This change is due to the increasing awareness of sports and its capacity in keeping the body and the mind fit. This has facilitated the need for development of sportswear to provide the requirements of the sports personnel. Hence, this project attempts to develop dynamic sports wears from 50% bamboo, 50%Cotton, and 50%Modal, 50%,cotton, It is then compared with 50%Baboo, 50%Cotton and 5 show its superiority, and also to analyze the performance characteristics and comfort properties of the same. When these Bamboo fibers are combined with Cotton they result in better properties for sportswear than Modal cotton.

Knitting is a method of forming fabric from a single strand of yarn, using two needles. The resulting fabric has given more than woven fabric. It is a technique to turn thread or yarn into a piece of cloth. Knitted fabric consists of horizontal parallel courses of yarn which is different from woven cloth as said by Prakash. C (2012). The courses of threads or yarn are joined together by interlocking loops in which a short loop of one course of yarn or thread is wrapped over another course. Fabric can be formed by hand or machine knitting, but the basic principle remains exactly the same i.e. pulling a new loop through the old loop. A knitted fabric consist of forming yarns into loops, each of which is typically only released after a succeeding loop has been formed and intermeshed with it so that a secure ground loop structure is achieved by Koushik. C.V

METHODOLOGY



Fabric Production
(Production of Weft Knitted Fabric with 0.30cm Loop Length)
The following stitch combination of fabrics are produced for our study
Knit Stitch – Single Jersey

- Knit and Tuck –

SINGLE JERSEY
Single jersey fabrics are generally used to make underwear and outerwear such as T-shirts. Compared to woven structures, knit fabric can more easily deform or stretch by compressing or elongating the individual stitches that from the fabric. This ability to stretch by stitch rearrangement adds to wearing comfort that, among other factors, is affected by Properties such as extensibility, air permeability, and heat insulation of garments made from knit fabrics.The knitted loops leave the needles the spacing of courses and wales decrease and the fabric shrinks in both directions thus affecting the properties of knitted fabric

KNIT TUCK
A tuck stich is composed of a held loop, one or more tuck loops and knitted loops. It is produced when a needle holding its loop also receives the new loop. The tuck loop assumes an inverted U-shaped configuration.

WATER VAPOUR PERMEABILITY TEST
Water vapour permeability of fabric samples was determined using an SDL Atlas instrument (M261, USA) according to ISO 14596. A test specimen was sealed over the open mouth of a test dish which contains water, and the assembly was placed in a controlled atmosphere. After

establishing equilibrium water vapour pressure gradient across the sample, successive weightings of the assembled dish were made and the water vapour permeation through the specimen was determined. The water vapour permeability (WVP) in g/m²/day was calculated by the equation; $WWWWWW=24\times MM\ AA\times tt$ where M is the loss in mass of the assembly over the time period t (in g), t is the time between successive weighing of the assembly in hours, A is the area of exposed test specimen (equal to the internal area of the test dish (in m²).

WICKING TEST

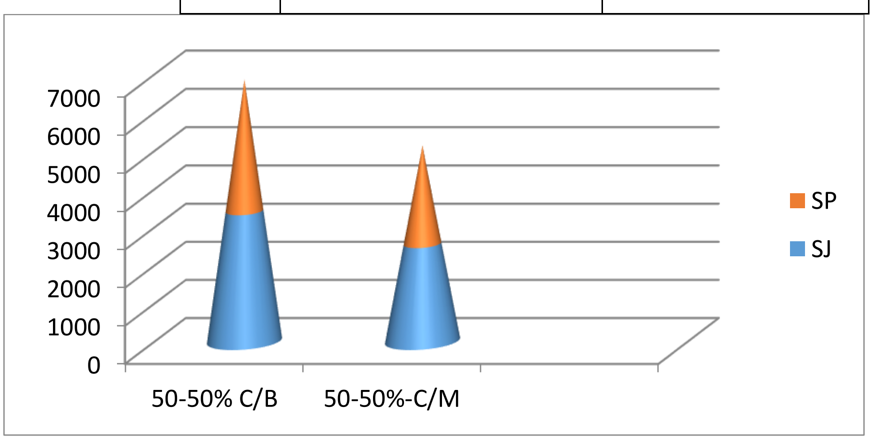
Wicking behaviour of fabric samples was determined according to DIN 53924. Ten specimens were cut along the warp and weft directions respectively to dimensions of 200 mm × 25 mm and suspended in a reservoir of 1% K2CrO4 with their bottom ends at a depth of 30 mm into the water. The height of the solution raised was measured and recorded in terms of mm after 60 seconds. Moisture transfer properties and drying rate of fabrics are two major factors affecting the physiological comfort of garments. Moisture transfer and quick dry behaviour of textiles depend mainly on the capillary capability and moisture absorbency of their fibbers. These characteristics are especially important in sport garments next to the skin or in hot climates. In these situations, it is critical that textiles are able to absorb large amounts of perspiration, draw moisture to the outer surface and keep the body dry. Therefore, in order to optimize these functionalities in sport clothing, and to support moisture management claims, it is necessary to determine the wicking behaviour and quick drying capability of functional fabrics.

RESULTS AND DISCUSSION

In this study, the results on the thermal comfort properties of water vapour permeability and wicking test has been seen and discussed. The result of the study discussed below.

WATER VAPOUR PERMEABILITY OF BOMBOO COTTON MODAL OTTON FABRIC

	50-50% C/B	**50-50%-C/M**
SJ	3420.004	2557.042
SP	3429.268	2568.98

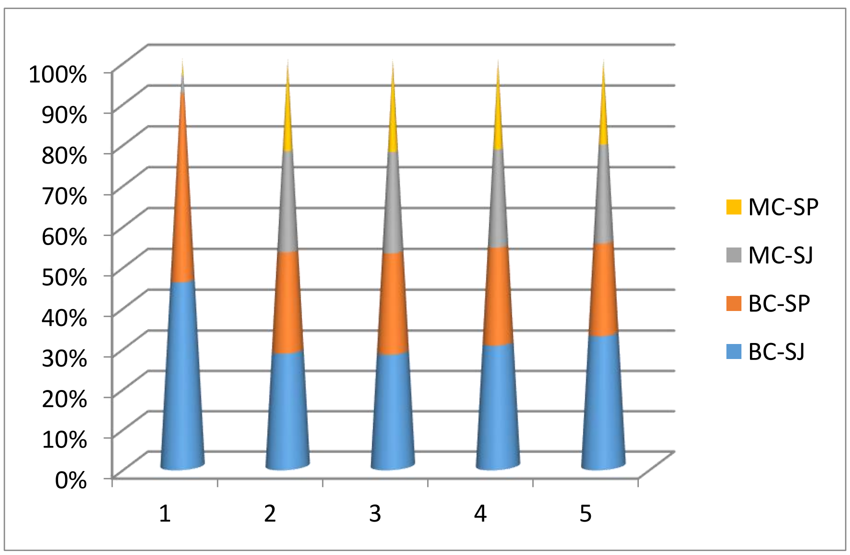


From the above Table & Figure it is clear that the fabric of Bamboo cotton from the two structures in the test of the Water Vapour permeability of Bamboo cotton single jersey gives good result compared to Modal cotton single jersey

WICKING

Wicking is the spontaneous flow of liquid in a porous substrate, driven by capillary forces. The capillary forces caused by wetting is wicking. The longitudinal wicking height determines the liquid transporting ability, and the faster the rate of wicking, the better the sweat transporting ability will be, hence the fabric feels more comfortable to wear. Wicking test of Modal fabric. From the above Table & Figure it is clear that the fabric of Bamboo cotton from the two structures in the test of the wicking of Bamboo cotton single jersey gives good result compared to Modal cotton single jersey

S.N	BC-SJ	BC-SP	MC-SJ	MC-SP
1	1.1	1.1	0.1	0.1
2	1.4	1.2	1.2	1.1
3	1.5	1.3	1.3	1.2
4	1.8	1.4	1.4	1.3
5	2.2	1.5	1.6	1.4



CONCLUSIONS

A “Warm – cool feeling” is a very important property, as a result of which a human can feel comfort or discomfort in various activities and environmental conditions. This feeling could be achieved by using different types of yarns. It was determined that higher air permeability is characterized for knits manufactured only from pure yarns. The thermal comfort properties of single jersey fabrics made from yarns of 50%50%bamboo cotton yarns were investigated. Water vapour permeability are significantly affected by the Moisture Vapour Transport. An increase in the bamboo fiber content in the fabric affects the thermal comfort properties. The wicking height of woven fabric, with longer yarn floats and less crimped yarns, is the highest. Increase in weft yarn density leads to a decrease in porosity, due to increased warp yarn crimp and therefore a decrease in wicking height.

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NATURAL DYEING OF COTTON FABRIC USING SPIRITUAL WASTE FLOWERS INDIAN FRAGRANT ROSE (ROSA INDICA) AND CHRYSANTHEMUM (CHRYSENTHEMUM INDICUM)

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Abstract

The present study aimed to access the cotton fabric is dyed with the extraction of flowers which is collected as a spiritual flower waste that dyed fabric tested for color fastness and tearing strength. Color fastness method done by the method of Color fastness to wash is the resistance of a material to change in any of its color characteristics as a result of washing with household detergent.

INTRODUCTION

NATURAL DYES

The Natural dyes or colorants derived from plants, invertebrates, or minerals. The majority of natural dyes are extracted from plant sources – roots, bark, leaves, flowers and wood and other organic sources such as fungi. Similarly some of the dyes are extracted from animals. All such dyes which derived from plants and animals are known as natural dyes. In China, dying with plants, barks and insects has been traced back more than 5,000 years. The essence of dyeing changed little over time. Typically, the dye material is put in a pot of water and then the textiles to be dyed are added to pot, which is heated and stirred until the color is transferred. Textile fiber may be dyed before spinning. Many natural dyes required the use of chemicals called mordant to bind the dye to the textile fabrics.

The natural dye throughout history, people have dyed their textile using common, locally available materials but scarce dyestuffs that produced brilliant and permanent colors such as the natural invertebrate dyes Tyrian purple and crimson kermes became highly prized luxury items in the ancient and medieval world. Plant based dyed cloth. Dyes from the new world such as logwood were brought to Europe by the Spanish treasure fleets, and the dyestuffs of Europe were carried by colonists to America.

COTTON FABRIC

Cotton is a soft, fluffy staple fiber that grows in a ball, or protective case, around the seeds of the cotton plants of the genus Gossypium in the mallow family Malvaceae. The fiber is almost pure cellulose, and can contain minor percentages of waxes, fats, pectin's, and water. Under natural conditions, the cotton bolls will increase the dispersal of the seeds. The plant is a shrub native to tropical and subtropical regions around the world, including the America, Africa, Egypt and India. The greatest diversity of wild cotton species is found in Mexico,followed by Australia and Africa. Cotton was independently domesticated in the Old and New World

SPIRITUAL WASTE

The present work deals with collection, handling, utilization, and management of the waste flowers that are coming out of the temples. Flower waste activated carbon in the soil, floral refuse has also been a challenge in Indian cities, and thus needs specific attention. Flowers are mostly used in temples, churches as offering, used in homes as a part of faith, marriages for decoration and some are leftovers after sales in market.

The floral waste generated can also be used for making natural Holi colours, rose water, essence, natural dyes, incense sticks, molting paper making and various ornamental purposes. Conventional methods of floral waste disposal in nearby water sources or in the landfill, incinerations, biogas and composting. More than 8 million tons of flowers are dumped in the river every year, along with toxic pesticides and insecticides used to grow them. In India many places of worship generate 20 tons of flower waste daily.

When Large volumes of flowers lack formalized waste management of in open t, they are often improperly disposed of in open places or in in many cases they are released to bodies of water. This can lead to water pollution, affects the waters surface that produces foul odors along with other plants, flowers absorbs carbon dioxide from the atmosphere and replace it with oxygen, which humans and animals need to breathe.

FLOWERS

Indian fragrant rose is an extremely popular species of rose in India. It is an erect shrub with prickles curved or almost absent. Flowers arise solitary or several in short panicles, fragrant, usually double, red to white on long smooth or glandular flower stalks it is also known as Rosa indica.

Chrysanthemum symbolize fidelity, optimism, joy and long life. They have long religious symbolism as they are often garlands and offering in pujas and temples as they are a prominent part of all celebrations. They include about 40 species horticultureal varieties.

METHODOLOGY

Collection of flower materials

The flower garland was collect from swamimalai temple near kumbakonam. The flower garland is used in temple for pooja. The garlands are collected after the spiritual puja.

Preparation of flower petals

The Flowers was collected and then dry the petals under the shadow for two weeks and make the petals into fine powder and mix them (Indian fragrant rose petals & Chrysanthemum petals) in equal ratio .

Extraction of dye from flower petals

The extractions of dye are taken by boiling the water for 10 minutes and adds the powder dye and boil it for 60 minutes 80 - 70° C. Then add the mordant and boil it for 20 minutes in80 - 70° C. The dye extract is ready to dye the cotton fabric.

Procedure

The cotton fabric was entered into the dye bath containing, dye extract and water. Then add mordant in dye solution and dyeing was continued for 60 minutes. Then the samples were rinsed with water and dried.

MASS PER UNIT TEST GSM

The Grams per unit test (GSM), It is the weight of the fabric measured in grams in the metric system, the mass per unit area of all types of textiles is expressed in grams per square meter, the average weight of the cotton fabric is 113.5g/m.

TEAR STRENGTH TEST

It is a testing standard for measuring the tear strength of vulcanized or thermoplastic rubbers. This standard describes the different test methods based on specimen geometry as the value for tear strength obtained depends on the shape of test specimen in addition to the testing speed and temperature.

COLOUR FASTNESS TO LIGHT

Light fastness, or color fastness to light, is the resistance of printed or pigmented materials to fading or color change due to exposure to sunlight or an artificial light source. The light fastness of print is predominantly governed by the pigment type used. The most known scales measuring the light fastness are the Blue Wool Scale, Grey scale and the scale defined by ASTM (American Standard Test Measure). On the Blue Wool Scale the light fastness is rated between1–8. 1 being very poor and 8 being excellent light fastness.

RESULT AND DISCUSSION

GSM of the cotton fabric before and after dyeing.

The size of the fabric used to dye.

The weight of the fabric before dyeing = 102.3g/m2

The weight of the fabric after dyeing = 113.5g/m2

CONCLUSION

In this project I conclude that the cotton fabrics have good dye ability using natural dyes. In this process the color fastness test prove that the dye powder has better performance. The result of this process is also positive.

So, in this project I conclude that the dyed fabric treated with flower petal extract is done & successful and it is the best utilization of spiritual flower waste.

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A STUDY ON THE CONSUMER ATTITUDES TOWARDS FAST MOVING CONSUMER GOODS IN THANJAVUR DISTRICT

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ABSTRACT

Fast Moving Consumer Goods are vital for the people in their day-to-day life. Their importance is giving the personality-oriented benefits to the people. Especially now a days customers focus on good tasty and healthy products. FMCG is the biggest potential market in the entire world, which increases income level of the market, is going to expand in near future. At the same time customers to find it very difficult to choose what we want in it because of the ingredients are high. Hence the researcher has made an attempt to study the consumer attitudes towards FMCG in Thanjavur District This study Concluded and recommended that familiarize exclusive show rooms need for FMCG and increase the simplest process in online purchasing methods.

KEY WORDS: Goods, Health, Company, Customer, Opportunity, Production

INTRODUCTION

Fast Moving Consumer Goods plays a vibrant role in part of economy in the world. Fast moving Goods are touch at all levels in the lives of customers. The Business of FMGC not only satisfy the customer's needs and also create the employment opportunities in the society. For instance, FMCGs represent the fourth-largest sector in the Indian economy and generate employment for more than three million people in downstream activities. Now a days nearly everyone in the world uses fast-moving consumer goods every day.

A Consumer is any person who buys or hires any goods or services for their own uses and is also called final goods. Consumer is the King of our product so consumer satisfaction is important for all the goods and services or companies. They are small scale consumer because they purchase for their daily uses from the retail shop, supermarket and warehouse outlet. The producers were pushed to fulfil the needs of consumers. Consumer goods can be classified into two types like durable goods and non-durable goods. Durable goods were used in long term and it will be used for many years so consumers avoid buying too often. Nondurable goods were used in short term so as consumed immediately or in short period. FMGC is similarly known as consumer-packaged goods. These products are over-sold at low prices such as prepared meals, beverages, baked goods, medicines, cleaning products, cosmetics and toiletries.

Consumer attitude is a feeling of favourableness or unfavourableness that an individual has towards an object. Consumer perception and expectation is the customer experience via consumption and interaction with the seller. Customer attitude is differed from person to person according to their stimuli. This can be influenced by cultural background, demographic factors, advertising, family lifestyle, personality, beliefs, reviews, and experience with similar products. These factors are influencing the customer to help in assessing the quality, worth of the product or service to meet the need.

REVIEW OF LITERATURE

Dr. M. Rifaya Meera and R. Mahalakshmi (2017), "Consumer Behaviour towards FMCG Products: A Study with Special Reference to Rajapalayam" published at Research J. Humanities and Social Sciences, this article analyses the hair care, household care, male grooming, female hygiene, and the chocolates and confectionery categories are estimated to be the fastest growing segments. They found that At present, urban India accounts for 66% of total FMCG consumption, with rural India accounting for the remaining 34%. However, rural India accounts for more than 40% consumption in major FMCG categories such as personal care, fabric care, and hot beverages. In urban areas, home and personal care category, including skin care, household care and feminine hygiene, will keep growing at relatively attractive rates. It concluded, Within the foods segment, it is estimated that processed foods, bakery, and dairy are long-term growth categories in both rural and urban areas. The growing incline of rural and semi-urban folks for FMCG products will be mainly responsible for the growth in this sector, as manufacturers will have to deepen their concentration for higher sales volumes. Moreover, Hence the researcher has made an attempt to study the consumer behaviour towards FMCG in the market of Rajapalayam Town only.

M. Shehbaz Qasim and Swati Agarwal (2015) "Consumer Behaviour towards selected FMCG in Delhi NCR", this paper aims the consumers' attitude towards Non-Alcoholic Beverages. This study is started with objectives of examining socio-economic background of respondents, analysing the factors influencing consumer preferences towards selected FMCG products, checking the level of satisfaction of consumers and knowing expectation of the consumers. This study reveals that consumer preferences are largely affected by age, sex, place, product, price, availability, psychological, people and brand influences.

STATEMENT OF THE PROBLEM

Fast Moving Consumer Goods is playing an important role in consumer's day to day life. FMCG is the biggest potential market in the entire world, which increases income level of the market, is going to expand in near future. At the same time customers to find it very difficult to choose what we want in it because of the ingredients are high. There are various brands of FMCG available in the market. The users of the FMCG know the product feature and other. Despite that, certain consumer is ready to accept any brand while certain others are insisting on a particular brand. This is to help the customers learn and decide to buy right products. This is very difficult because of the consumers has different needs, attitude, expectations and also a sea changes in the standard of living and life styles. At present the consumers are more dynamic, their taste, preferences are also changing. The consumers are also looking product differentiation and the convenience offered. The consumer has certain expectations from branded items in terms of its quality, price and packaging. The consumers are finding various problems in selecting their FMGCs. In order fulfil their expectation to know the consumer behaviour in the purchase decision in the FMCGs products. In this backdrop it is identified that there is a need for research work in the field of consumers' perception and attitude towards FMCGs in Thanjavur district.

OBJECTIVES OF THE STUDY

- To examine the consumer attitudes towards FMCG in Thanjavur.
- To analyse the consumers attitudes on selected FMCG at the time of purchase
- To ascertain the consumer attitudes in their pre-purchasing and post-purchase of select fast moving consumer goods
- To offer suitable suggestions based on the findings of the study.

HYPOTHESES

- There is no relationship between the educational status of the respondents and Factors influence to purchase of the respondents.
- There is no relationship between the age of the respondents and purchase decision of the respondents.

RESEARCH METHODOLOGY

For purpose of this study the primary data has been directly collected by Questionnaire. The secondary data for this study has been collected from various publications, Journals, Magazines and Books.

SAMPLING DESIGN:

The researcher is interested to study the consumer attitude towards FMCG products in Thanjavur. Since the consumers are large number, in the study area, the researcher has selected 80 customers used Convenience Sampling Method.

LIMITATION OF THE STUDY

- The geographical area and the time were limited factor for the study
- Some respondents may not answer all questions in the questionnaire with correctness
- The findings of the study are exclusively based on the information provided by the respondents

DATA ANALYSIS AND INTERPRETATION

Age Wise Classification of Respondents

Age	**No. of Respondents**	**Percentage**
Below 20	10	12.50
21-30	40	50.00
31-40	17	21.25
above 40	13	16.25
Total	**80**	**100.00**

Gender Wise Classification of the Respondents

Gender	**No. of. Respondents**	**Percentage**
Male	34	42.50
Female	46	57.50
Total	**80**	**100.00**

Educational Status of the Respondents

Educational level	No. of respondents	Percentage
School level	13	16.25
Graduation	28	35.00
Post Graduation	21	26.25
Diploma	11	13.75
Professional	7	8.75
Total	**80**	**100.0**

Factors Influencing Purchase Decision

Purchase decision	No. of respondents	Percentage
Self	36	45.00
Friend	13	16.25
Family member	20	25.00
Adverting	11	13.75
Total	**80**	**100.00**

H 1:

There is no relationship between the educational status of the respondents and Factors influence to purchase of the respondents.

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.429[a]	18	.632
Likelihood Ratio	17.625	18	.481
Linear-by-Linear ssociation	2.485	1	.115
N of Valid Cases	80		

The significance value of chi – square test 0.632 is more than the 0.05. Hence, the Hypothesis is accepted. Hence, it is concluded that there is no relationship between the educational status of the respondents and Factors influence to purchase of the respondents.

H 2:

There is no relationship between the age of the respondents and purchase decision of the respondents.

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.990[a]	24	.520
Likelihood Ratio	27.027	24	.303
Linear-by-Linear Association	.027	1	.868
N of Valid Cases	80		

The significance value of chi – square test 0.520 is more than the 0.05. Hence, the Hypothesis is accepted. Hence, it is concluded that there is no relationship between the age of the respondents and taken of purchase decision of the respondents.

RECOMMENDATIONS

The researcher would like to suggest the following points, so the company can easily sell their product to their Consumer.

- It is recommended that familiarize exclusive show rooms particularly for FMCG.
- The producer should increase the advertisement through the Newspapers /Magazines.
- The Companies can reduce their prices by cutting the cost on the advertisement in radio because the radio hearing people less in the number today.
- It is advised that the guarantee warrantee periods to revise for FMCG.
- Online shopping procedure should be understandable and easy to the customers.
- Information relating to promotion methods needed to communicate to all customers to increase more awareness regarding the sale's promotional methods.
- Stores/shops are to inspire the regular buyers by way of promotional offers.
- The company should study the brand switching customers in keen and reduce the problems and increase the customer needs and wants.

CONCLUSION

The present paper concludes that the successes of all the industrialist's motive is create new customers and retain their existing customers for their products. Companies to sell their products in standard price with good quality and avail the products in all the stores to attract the new customers also. Product Quality is the most critical component that impacts the purchase of products. From our study, it was found that important option for customer is taste and health aspects therefore, the producers should focus on these aspects and produce the products. The fulfilment of wants can motivate them to make purchase or to find different goods and services for the better fulfilment of those needs. Needs could be both positive, negative, utilitarian decadent, conscious or unconscious, and accordingly goals are formulated. From the above analysis, that the consumer faces some problems. It is also concluded that the company may try to implement the above suggestion in the study area.

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AI-DRIVEN MARKET TRENDS ANALYSIS FOR STRATEGIC E-COMMERCE INNOVATION

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ABSTRACT:

The rapid evolution of artificial intelligence (AI) has significantly transformed the landscape of e-commerce, enabling businesses to identify, analyze, and respond to market trends with unparalleled accuracy and speed. This paper explores the role of AI-driven market trend analysis in fostering strategic innovation within the e-commerce sector. By leveraging machine learning, natural language processing, and predictive analytics, AI systems can process vast datasets to uncover hidden patterns, anticipate consumer behavior, and predict emerging market demands.

Key Words:

- Artificial Intelligence (AI),
- Market Trends Analysis,
- E-Commerce Innovation,
- Predictive Analytics,
- Data-Driven Decision Making,
- Consumer Behavior

Introduction:

In today's rapidly evolving digital economy, e-commerce has become a cornerstone of global trade, revolutionizing the way businesses operate and consumers shop. With the advent of artificial intelligence (AI), the landscape of e-commerce is undergoing a profound transformation. AI technologies offer unparalleled capabilities to analyze vast amounts of market data, uncover hidden trends, and enable data-driven decision-making. These advancements not only optimize operations but also empower businesses to innovate strategically, staying ahead in an intensely competitive market.

Market trends analysis is pivotal for identifying emerging consumer behaviors, forecasting demand, and tailoring offerings to meet evolving preferences. Traditional methods of analyzing trends often fall short in handling the complexity and velocity of modern market dynamics. Here, AI emerges as a game-changer, leveraging machine learning, natural language processing, and predictive analytics to deliver precise and actionable insights.

This paper explores the role of AI in market trends analysis and its implications for strategic innovation in e-commerce. It examines cutting-edge AI tools and methodologies, highlights successful implementations, and discusses challenges and ethical considerations. By delving into AI's transformative potential, this paper aims to provide a roadmap for businesses seeking to harness AI-driven insights to shape the future of e-commerce.

Definition of the term:

This involves using AI tools like machine learning, data analytics, and predictive models to extract insights from vast amounts of data. The objective is to identify emerging consumer behaviors, market demands, and competitive landscapes. By applying these insights, e-commerce businesses can make informed strategic decisions, optimize their operations, improve customer experiences, and innovate their offerings to stay competitive in a dynamic digital marketplace.

Importance of AI-Driven Market Trends Analysis:

Enhanced Market Understanding

AI technologies like machine learning (ML) and data analytics can process vast amounts of data from various sources, including customer behavior, sales patterns, and competitor activity. This leads to a deeper understanding of market trends, helping e-commerce businesses identify emerging opportunities and challenges.

Real-Time Data Utilization

With AI, e-commerce companies can track real-time consumer preferences, buying behavior, and market shifts. This enables timely and data-driven decisions, ensuring businesses can respond quickly to changing consumer demands and emerging trends.

Personalization and Customer Experience

AI enhances personalization, delivering tailored product recommendations, targeted marketing, and personalized user experiences. This helps improve customer satisfaction, increase conversion rates, and foster long-term loyalty.

Competitive Advantage

By leveraging AI-driven insights, e-commerce businesses can gain a competitive edge. They can optimize pricing strategies, inventory management, and marketing efforts, leading to cost reductions, higher efficiency, and improved profitability.

Innovation and Strategic Planning

AI provides predictive analytics, helping businesses forecast future trends, consumer behaviors, and market conditions. This supports more effective strategic planning, enabling businesses to innovate with confidence, create new product offerings, and stay ahead of competitors.

Sustainability and Operational Efficiency

AI-driven insights can optimize supply chain management, reduce waste, and improve operational efficiency, contributing to more sustainable business practices

Objectives of the study:

- To Explore the Role of AI in Market Trend Analysis
- To Identify Key Drivers of Strategic Innovation in E-Commerce
- To Evaluate the Effectiveness of AI Tools in Forecasting Market Trends
- To Develop a Framework for Integrating AI into Strategic Planning
- To Identify Future Opportunities in AI for E-Commerce

Role in Forecasting Consumer Behaviour, Demand Patterns, and Market Trends

Understanding consumer behavior, demand patterns, and market trends is essential for businesses to thrive in competitive markets. Forecasting plays a pivotal role in this process by providing insights that enable companies to anticipate customer needs, optimize resource allocation, and develop effective strategies. Accurate forecasting helps organizations navigate market uncertainties, reduce risks, and capitalize on emerging opportunities. By analyzing historical data, current market conditions, and future expectations, businesses can make informed decisions that drive growth and enhance customer satisfaction

Ethical Considerations in AI Implementation

The rapid advancement of Artificial Intelligence (AI) has transformed industries, revolutionizing processes, decision-making, and innovation. However, as AI becomes increasingly integrated into various aspects of society, ethical considerations have emerged as a critical area of focus. Issues such as bias, transparency, accountability, and the potential for misuse highlight the importance of ensuring responsible AI implementation. Ethical AI is not only a moral obligation but also a necessity for fostering trust, fairness, and long-term societal benefits

Emerging Trends in AI-Driven Predictive Analytics

AI-driven predictive analytics is reshaping industries by enabling organizations to uncover patterns, anticipate future outcomes, and make data-driven decisions with unprecedented accuracy. As this field evolves, emerging trends such as the integration of advanced machine learning algorithms, real-time analytics, and explainable AI are transforming how businesses harness data for strategic advantage. These innovations are empowering organizations to predict customer behavior, optimize operations, and respond proactively to market changes.

Data Quality and its Impact on AI Success

Data quality is a fundamental component that directly impacts the success of AI applications. High-quality data ensures accuracy, reliability, and relevance, which are crucial for AI systems to generate meaningful insights and make informed decisions. Poor data quality, on the other hand, can lead to biased results, inaccurate predictions, and flawed conclusions, undermining the effectiveness of AI models. As AI continues to drive innovation across industries, ensuring data quality has become essential to unlocking the full potential of AI.

Customer Engagement Strategies Enabled by AI

AI has transformed customer engagement by enabling personalized, data-driven interactions that enhance the customer experience. Through AI-powered tools such as chatbots, predictive analytics, and recommendation systems, businesses can gain deeper insights into customer preferences and behaviors, leading to more targeted and effective engagement strategies. These AI-driven solutions help organizations anticipate customer needs, optimize communication, and improve satisfaction. By leveraging AI, companies can build stronger relationships, increase loyalty, and drive long-term growth.

Data Sources for AI-Driven Analysis:

Discussion on primary data sources like social media platforms, online reviews, sales data, and web traffic. Importance of structured and unstructured data integration.

Techniques for AI-Driven Analysis:

Sentiment analysis for understanding consumer preferences. Predictive analytics for forecasting market demands and Cluster analysis for segmenting customer demographics.

Applications in Strategic E-Commerce Innovation:

Personalized Marketing: AI's role in tailoring product recommendations and dynamic pricing. Inventory Management .Predicting stock requirements to optimize supply chain efficiency. Customer Retention. AI-driven loyalty programs and chatbot assistance for enhanced engagement.

Challenges and Solutions:

Ethical concerns: Addressing data privacy and algorithmic bias. Implementation hurdles: Overcoming high costs and integration complexities.Proposed solutions: Adoption of transparent AI models and scalable AI platforms.

Future Prospects:

Potential for AI to drive hyper-personalization and immersive shopping experiences using AR/VR. Expansion of AI-driven trend analysis into emerging markets and niche industries.

Conclusion

AI-driven market trend analysis is not just a tool but a necessity for businesses aiming to innovate in e-commerce. By leveraging AI, companies can anticipate changes, respond proactively, and maintain a competitive edge. As technology evolves, the integration of AI into strategic decision-making will continue to shape the future of e-commerce.

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN MODERN BUSINESS OPERATIONS

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ABSTRACT

Artificial Intelligence (AI) is increasingly becoming a core component of modern business operations, enabling companies to streamline processes, enhance decision-making, and improve customer experiences. This paper explores how AI technologies are integrated into various business functions, including supply chain management, marketing, and customer service, to drive operational efficiency and innovation. By automating routine tasks, providing predictive insights, and optimizing workflows, AI is revolutionizing business practices and fostering a competitive edge. The study highlights both the opportunities and challenges businesses face in adopting AI, offering recommendations for effective implementation and management of AI-driven operationsAs businesses face the pressures of globalization and technological advancement, Artificial Intelligence provides innovative solutions to enhance operational processes. This paper highlights the impact of AI on business operations by focusing on its applications in automation, data analysis, and strategic planning. The study provides insights into how AI empowers businesses to improve operational efficiency, reduce human error, and maintain agility in dynamic market conditions. In the era of digital transformation, Artificial Intelligence is emerging as a key enabler of modern business operations. This paper explores the diverse applications of AI in business, such as process automation, predictive analytics, and data optimization. It delves into the operational benefits, including cost reduction, efficiency improvements, and innovation, while addressing the organizational and ethical challenges associated with AI implementation in business practices.

Keywords: chain management, Business Competitiveness, Eco-Friendly Materials, Fashion Technology.

INTRODUCTION

The fashion business is one of the most resource-intensive and environmentally damaging industries in the world, despite its reputation for creativity and innovation. It is in charge of around 20% of wastewater production and 10% of carbon emissions worldwide. Fast fashion's growth and the quick changes in fashion trends have made problems like resource depletion, labour exploitation, and textile waste worse. Stakeholders in the sector are looking for creative answers to these problems as the need for more sustainable practices grow.

A game-changing technology, artificial intelligence (AI) has the potential to completely change how the fashion industry approaches sustainability. AI is a potent instrument for promoting productivity and creativity because of its capacity to analyse enormous volumes of data, spot trends, and offer useful insights. Applications of AI are numerous and significant, ranging from creating environmentally friendly materials to streamlining manufacturing procedures and improving supply chain transparency.

This study examines how AI is incorporated into several facets of the fashion lifecycle, emphasising how technology may support ethical and environmentally friendly practices. In order to demonstrate how AI may assist in transforming the fashion industry into one that is more sustainable and ethical, the paper will look at real-world examples, technology developments, and possible obstacles. AI stands out as a key facilitator for the fashion industry's shift to a more sustainable and just future as the worldwide call for sustainability becomes stronger.

AI in the Business Operations

Material Discovery and Development:

Artificial Intelligence (AI) has revolutionized business operations across industries by automating processes, enhancing decision-making, and providing innovative solutions. As businesses face increasing competition and demand for efficiency, AI serves as a powerful tool to streamline operations, reduce costs, and enhance customer experiences. Below are key areas where AI plays a critical role in modern business operations.

Automation of Repetitive Tasks

AI automates routine and repetitive tasks, such as data entry, document processing, and customer inquiries. This increases efficiency and allows employees to focus on more strategic tasks. For example, Robotic Process Automation (RPA) is widely used in finance and human resources to automate payroll processing, invoice generation, and compliance reporting.

Data-Driven Decision Making

AI empowers businesses to make data-driven decisions by analyzing large volumes of data in real-time. Machine learning algorithms identify patterns and trends that help managers make informed choices in areas like product development, marketing strategies, and inventory management.

Customer Service and Engagement

AI enhances customer service by utilizing AI-powered chatbots and virtual assistants that provide 24/7 support. These systems handle basic inquiries, provide product recommendations, and resolve common issues, improving customer satisfaction and reducing operational costs. AI also personalizes customer interactions by analyzing preferences and behavior patterns.

Supply Chain and Logistics Optimization

AI is increasingly being used to optimize supply chains by predicting demand, managing inventory, and improving delivery efficiency. Predictive analytics and machine learning algorithms help businesses forecast customer demand, optimize warehouse management, and ensure timely delivery of goods.

Marketing and Personalization

AI helps businesses create targeted marketing campaigns by analyzing customer data and predicting purchasing behaviors. Through personalization techniques, AI recommends products to customers based on their past interactions and preferences, thus enhancing engagement and conversion rates. AI tools also optimize ad spend by targeting the right audiences with the right message at the right time.

AI in Supply Chain Transparency

1.Traceability and Ethical Sourcing:

- **Blockchain Technology:** Blockchain solutions driven by AI offer an unchangeable and transparent record of the movement of raw materials and final goods. This guarantees end-to-end traceability, enabling companies to confirm the source of resources and guarantee adherence to labour laws, sustainability objectives, and ethical norms.
- **Predictive Analytics:** Predictive analytics, which makes use of sophisticated AI, assists in locating supply chain inefficiencies and possible environmental effects. By enabling proactive actions like waste reduction, carbon footprint minimisation, and resource optimisation, these insights guarantee a more sustainable and accountable supply chain.

2.Inventory Management:

- **Demand Forecasting:** To precisely forecast demand, AI algorithms examine past data, industry trends, and consumer behaviour. This aids in resource optimisation, cost-efficiency improvement, and the reduction of unsold inventories and overproduction. Businesses can optimise operations and cut waste by modifying production schedules and stock levels based on their anticipation of future demand.

Artificial Intelligence (AI) plays a significant and transformative role in eCommerce, providing various tools and capabilities to enhance customer experiences, optimize business processes, and drive overall growth. Here are some key areas where AI is being utilized in eCommerce:

1. Personalized Customer Experience

- **Product Recommendations**: AI analyzes customer behavior, preferences, and past purchases to suggest products that are likely to interest them. This is commonly seen in eCommerce platforms like Amazon and Netflix, where recommendations drive sales.
- **Dynamic Pricing**: AI can adjust prices based on factors such as demand, inventory levels, competitor prices, and customer profiles, ensuring competitive pricing and optimized profit margins.
- **Content Personalization**: AI-powered algorithms can modify website content to match the preferences of different users, offering a tailored shopping experience.

2. Chatbots and Virtual Assistants

- **24/7 Customer Service**: AI chatbots are increasingly used to provide immediate assistance to customers, answering questions, resolving issues, and guiding users through the shopping process. Chatbots improve customer satisfaction by providing quick responses, even during non-business hours.
- **Personalized Interactions**: AI-driven assistants can help users find products by asking relevant questions, offering product suggestions, or guiding them through their shopping journey.

3. Inventory and Supply Chain Management

- **Demand Forecasting**: AI uses historical data and trends to predict future demand for products, enabling businesses to optimize inventory levels and prevent stockouts or overstocking.
- **Supply Chain Optimization**: AI helps streamline logistics by predicting shipping times, managing deliveries, and optimizing routes to ensure fast and efficient order fulfillment.

4. Visual Search and Recognition

- **Visual Search**: AI allows customers to upload images of products they are interested in, and the system can identify similar items in the store, helping them find the right product quickly.
- **Product Recognition**: AI can help identify items within images or videos, allowing users to click on or purchase products directly from a picture or video on social media platforms.

5. Voice Commerce

- **Voice Search**: With the rise of smart speakers (e.g., Amazon Alexa, Google Assistant), AI is enabling customers to search for products, make purchases, and even track orders using voice commands.
- **Voice-Activated Shopping**: AI-driven voice assistants are making it easier for customers to interact with eCommerce platforms hands-free, improving the shopping experience.

6. Fraud Detection and Prevention

- **Transaction Monitoring**: AI can analyze purchasing behavior in real-time to identify and flag suspicious activity, helping prevent fraudulent transactions.
- **Security Algorithms**: Machine learning can detect patterns of fraud and offer more robust security measures for both merchants and customers

7. Customer Sentiment Analysis

- **Social Listening**: AI can analyze customer reviews, social media mentions, and feedback to gauge customer sentiment toward a product or brand.
- **Market Insights**: Sentiment analysis helps businesses adjust marketing strategies, address customer pain points, and improve product offerings based on real-time data.

8. Search Engine Optimization (SEO)

- **Search and Discovery**: AI can optimize the search functionality on eCommerce websites, improving the relevance and accuracy of results. It can help customers find products faster and with greater precision.
- **AI Content Creation**: AI tools like GPT can assist in generating product descriptions, blogs, and other content that improves search engine rankings.

9. Automated Marketing

- **Email Marketing**: AI can automate email campaigns, segment customers, and send personalized product recommendations, offers, and promotions based on user behavior.
- **Ad Targeting**: AI analyzes user data to optimize digital ads, ensuring that ads are targeted to the right audience at the right time, maximizing the chances of conversion.

10. Augmented Reality (AR) and Virtual Reality (VR)

- **Virtual Try-Ons**: AR technology, powered by AI, allows customers to try on clothes, shoes, or even test makeup virtually before making a purchase, enhancing the customer experience and reducing returns.
- **Virtual Stores**: Some brands use VR to create virtual shopping experiences, allowing customers to browse and shop in a fully immersive, 3D environment.

Challenges and Ethical Implications of AI in Modern Business Operations

Key challenges and considerations for integrating AI in eCommerce:

1. Data Privacy and Security

- **Sensitive Data Handling**: AI systems require large amounts of data to function effectively, especially in personalized marketing, recommendations, and customer support. However, managing sensitive customer data, such as payment details, personal information, and browsing habits, poses a significant security risk.
- **Compliance with Regulations**: Companies must ensure compliance with global data protection regulations, such as the **General Data Protection Regulation (GDPR)** in the EU or **California Consumer Privacy Act (CCPA)**. Violating these regulations can lead to hefty fines and loss of customer trust.
- **Trust Issues**: Customers may be wary of how their data is being used, especially in the context of AI-driven personalization. Clear communication and transparency regarding data collection and usage are essential.

2. High Initial Costs and Investment

- **Infrastructure Costs**: Implementing AI systems, including hardware, software, and data management platforms, can require substantial upfront investment.

- **Talent Acquisition**: Building and maintaining AI-driven systems often requires specialized talent in data science, machine learning, and AI development, which can be costly and difficult to find.
- **Scalability**: As eCommerce platforms grow, AI systems must scale efficiently. Maintaining scalability can add to the ongoing costs of AI integration.

Case Studies and Practical Applications

Siemens: AI in Industrial Manufacturing

- **Industry**: Industrial Manufacturing
- **AI Application**: Predictive Maintenance and Production Optimization
- **Overview**: Siemens, a global leader in industrial manufacturing, utilizes AI and machine learning to improve operational efficiency and prevent machine failures through predictive maintenance. The company uses AI to monitor equipment in real-time, enabling proactive repairs and optimizing production lines.
- **AI Implementation**:
  - **MindSphere**: Siemens developed **MindSphere**, a cloud-based IoT (Internet of Things) operating system that integrates AI and analytics to process data from machinery and sensors. This system predicts failures, reduces downtime, and helps optimize production scheduling.
  - **Machine Learning for Predictive Maintenance**: AI models analyze data from machines to predict maintenance needs before equipment failure occurs, minimizing disruptions in production.
- **Impact**:
  - **Reduced Downtime**: By predicting maintenance needs, Siemens has reduced downtime significantly, improving overall efficiency.
  - **Cost Savings**: AI-driven predictive maintenance helps avoid costly emergency repairs and extends the lifespan of equipment.
- **Challenges**: Integrating AI with legacy systems in older machines and ensuring data accuracy and reliability remain ongoing challenges.

2. Uber: AI in Dynamic Pricing and Route Optimization

- **Industry**: Transportation and Logistics
- **AI Application**: **Dynamic Pricing and Ride Matching**
- **Overview**: Uber leverages AI extensively to optimize its operations, including dynamic pricing models, efficient route planning, and matching riders with drivers.
- **AI Implementation**:
  - **Dynamic Pricing (Surge Pricing)**: Uber uses AI to adjust ride fares in real-time based on demand, traffic conditions, and driver availability. This model helps balance supply and demand, ensuring drivers remain incentivized while meeting rider needs.
  - **Route Optimization**: Uber's AI-driven algorithms calculate the most efficient routes for drivers by analyzing traffic, weather, and historical trip data. The system helps drivers minimize wait times and fuel consumption.
  - **Matching Riders with Drivers**: AI algorithms match riders with the most suitable drivers based on proximity, past ratings, and ride preferences, improving overall service quality.

- **Impact**:
    - **Improved Efficiency**: Dynamic pricing and optimized route algorithms result in faster, more cost-efficient services for both riders and drivers

Conclusion

Artificial Intelligence (AI) has become a driving force behind the transformation of modern business operations, enabling companies to streamline processes, enhance decision-making, and deliver personalized experiences to customers. From automating routine tasks and optimizing supply chains to improving customer service and driving innovation, AI is reshaping industries and providing businesses with new opportunities for growth and efficiency.

AI's ability to process large volumes of data in real-time, generate insights, and make predictive decisions has proven invaluable in sectors such as manufacturing, retail, banking, and healthcare. Companies like Siemens, Amazon, Starbucks, and Zara are harnessing AI for purposes ranging from predictive maintenance and inventory management to personalized marketing and demand forecasting. The ability to leverage AI in such ways has led to cost reductions, improved operational efficiencies, and enhanced customer satisfaction.

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MACHINE LEARNING APPROACHES FOR FRAUD DETECTION IN FINANCIAL TRANSACTIONS

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Abstract:

Recent research has demonstrated that machine learning approaches can be successfully deployed to detect fraudulent transactions in substantial amounts of payment data. Payments-related fraud is a key component of cyber-crime agency. These methods can identify fraudulent transactions in real time, something that human auditors would not be able to achieve.

In this project, we use publicly available simulated financial transaction data to apply a variety of supervised machine learning algorithms to the problem of fraud detection. We want to show that high class imbalance data can be accurately classified using supervised ML algorithms.

We show that it is possible to distinguish between fraudulent and lawful transactions using exploratory analysis. We also show that tree-based methods, such as Random Forest, perform significantly better than Logistic Regression given a well-separated dataset.

Introduction:

Real-world problem-solving has always benefited from machine learning. It is now widely utilised in all industries, including banking, insurance, and e-commerce. All of the reviewing tasks were previously completed by hand. But with the increase in the processing power of systems and the advancement in statistical modeling, the acceptance of Machine Learning in every sector has increased. In this blog, we will see fraud detection algorithms using Machine Learning.

Fraud has long been a serious problem in a variety of industries, including banking, medicine, insurance, and many more. Fraudulent activities have increased along with the number of online transactions made using various payment methods, including credit/debit cards, PhonePe, Gpay, Paytm, etc. Fraudsters and other criminals have also developed incredibly sophisticated escape routes so they can steal more. Creating a secure system for authentication and combating customer fraud has become a difficult challenge because no solution is faultless and there is always a vulnerability. Hence, algorithms for fraud detection are quite helpful in reducing fraud.

Keywords: systematic literature review, Kitchenham technique, machine learning, fraud detection, and financial fraud.

Models and Procedures for detecting fraud:

1. Supervised education
2. Unsupervised education
3. Guided learning in part
4. Reinforcement in education

Existing System:

You can slice and dice enormous amounts of data because robots can process vast datasets far more quickly than people can. It implies:

Faster and more effective detection: The technology can spot suspicious patterns and actions that could have taken human agents months to discover.

Decreased manual review time: In a similar vein, letting computers analyse all the data points for you can significantly cut down on the time spent manually examining information.

Larger datasets yield better predictions: A machine learning engine gets more proficient the more data it is fed. Hence, while enormous datasets can occasionally make it difficult for people to identify patterns, the situation is exactly the opposite with an AI-driven system.

Cost-effective remedy: You only need one machine-learning system to process all the data you put at it, regardless of volume, as opposed to adding more RiskOps agents. This is perfect for companies who see seasonal fluctuations in traffic, checkouts, or signups. A machine learning system can help your business grow without significantly raising risk management expenses at the same time.

Proposed System:

Notwithstanding its benefits, there will always be situations where traditional manual evaluations are preferred.

fewer controls: Blackbox machine learning engines in particular are susceptible to errors that go undetected.

Positive errors: A valid action that is mistakenly categorised as fraud will have a detrimental impact on the entire system. In that regard, a poorly calibrated machine learning engine might produce a feedback loop in which the future accuracy of your results decreases as more false positives go undetected.

No comprehension by humans: It's difficult to overcome good old psychology when trying to figure out why a user activity is suspect.

Literature Review:

[1] We looked at the most recent methods for anomaly detection and trusting relaying in an IoT environment. Also, we reviewed many techniques and algorithms, both old-school and cutting-edge, for detecting financial fraud. Fission computing was the creative approach put out by V. Sharma et al. In order to maintain trust and uphold privacy regulations in a social IoT context, the suggested approach relies on edge-crowd integration. They presented a case study on the detection of fake news sources in a social IoT context and carried out analysis through numerical simulations while utilising a secure network.

[2] Pervasive Online Social Networks (POSNs) are also given an ubiquitous trust management framework that can foster high user trust while monitoring costs are kept to a minimum.

[3]A model based on cognitive tokens was put up as a way to find anomalies in the IoT environment. This approach provides an Intelligent Sensing Model for Anomalies (ISMA) detection by purposefully producing inaccurate data to attract the abnormal users.

[4] Van Wyk Hartman offered automatic fraud and network topology detection. The system schedules the follow-up and field investigation to look into and correct the fraud if it is found in the distribution network.

[5] Moreover, techniques and systems for detecting online fraud have been put forth. For an authentication, the rear end device generates a second dynamic device identification based on the front end device's dynamic device characteristics. The front end device generates a first dynamic device identification based on dynamic device attributes.

[6] Several learning techniques and algorithms have been used for anomaly identification and data analysis. A web service-based collaborative strategy for financial fraud detection has been proposed , as have learned methods using supervised, unsupervised, and artificial neural networks.

[7] Moreover, a system for effective fraud detection that combines classification and clustering approaches and is adaptable to behavioural changes has been developed. The suggested financial fraud detection system consists of two steps, with the first stage using the BOAT algorithm, a scalable algorithm, to identify the anomaly by comparing the incoming transaction against the transaction history. In the second stage, the false alarm rate suspected anomalies are compared to the fraud history database to determine whether they are the result of a fraudulent transaction or any recent changes to the expenditure profile. Since the training dataset is dynamically changing, the BOAT technique may also incrementally update a decision tree.

[8] An effective financial fraud detection system that is flexible to behaviour changes by integrating classification and clustering approaches, a scalable algorithm termed BOAT, has also been proposed.The detection of fraud is based on the genetic algorithm computation and client behaviour.

Conclusion:

In this study, we examined the most recent methods for identifying financial fraud using machine learning and artificial neural networks, and we carried out an experiment using actual financial data from Korea. The feature selection process based on the filter method, the clustering process, and the classification process make up the machine learning-based process. However, the feature selection procedure must be carried out in accordance with the input data. Experimental results demonstrate that machine learning-based methods have higher detection performance than neural networks at various ratios. The best clustering method and classification algorithm combination must also be confirmed using a machine learning-based process. In the upcoming effort, validation of various financial data sets will be done. Very high detection accuracy was attained by neural networks at ratios of 95:1 and 99:1, which are remarkably close to the ratio that exists in reality. The procedure, however, takes a bit longer than machine learning. In our upcoming study, we want to use deep artificial neural networks and machine learning to increase the accuracy and processing speed of the financial fraud process in real time.

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DESIGN AN ENMBEDDED SYSTEM FOR INTELLIGENT TRAFFIC MANAGEMENT

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ABSTRACT

The present era is marked by rapid improvement and advances in technology. One of the most essential areas that demand improvement is the traffic signal, as it constitutes the core of the traffic system. The number of vehicles has increased drastically, but in contrast, the capabilities of our roads and transportation systems remain underdeveloped and as a result, fail to cope with this upsurge in the number of vehicles. In this paper we are going to discuss the current status and proposed system for intelligent traffic management system [ITMS]. It contains implementation procedure for automobile networks and Architecture of the vehicular ad-hoc network (VANET). We demonstrate local traffic management at an intersection that satisfies the needs of future smart cities, including fairness, a shorter commute time, an acceptable traffic flow, less traffic congestion, and giving priority to emergency vehicles. The proposed system works better than the conventional management system, according to simulation data, and might be a candidate for the traffic management system in upcoming Smart Cities. The average waiting time (delay) is greatly decreased by our suggested adaptive method, which also results in an increase in the number of vehicles being serviced. In addition, we demonstrate the STS hardware prototype that was put into use.

I.INTRODUCTION

1.1. Status of Road Traffic Management Currently:

Road Static signals are used in traffic management to control the flow of traffic across the nation. Three values are used to differentiate traffic signals: RED for stop, YELLOW for get ready, and GREEN for go. All of these are adjusted depending on a control system that uses a timed cycle to do so. The timing device's Value is influenced by lane count. It runs a timer rotation cycle of generalized value, or 120 seconds, during which the suggested system emits a GREEN signal for 26 seconds and a RED signal for the remaining 116 seconds. The final 8 seconds of the skip are for the YELLOW signal time, which functions as a sublayer between the two systems to ensure seamless performance.

1.2. Offering a Dynamic Approach as a 2 Solution

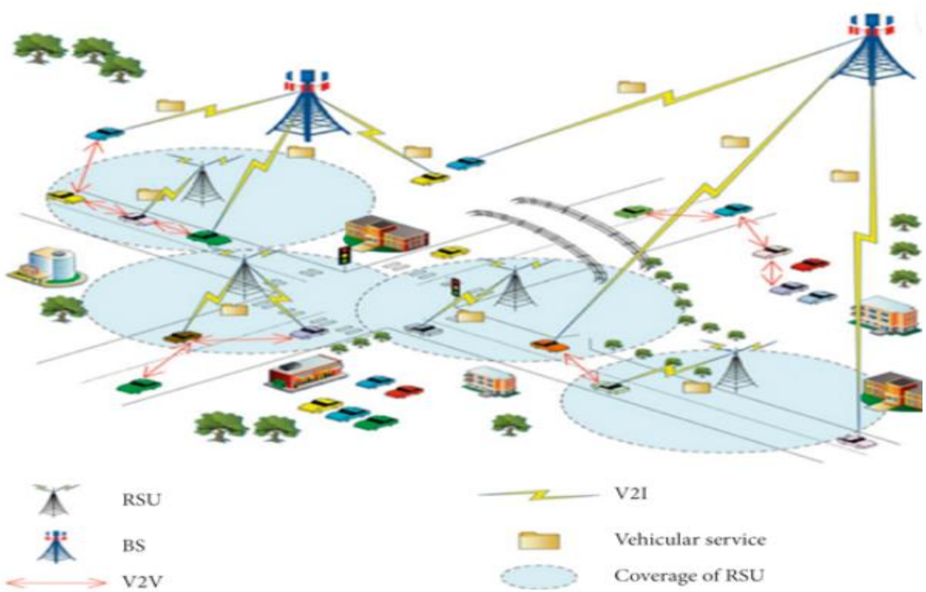
The proposed method would offer an intelligent remedy for the issue, allowing the existing static system to adapt to the surroundings, determine traffic density, and control it more precisely and orderly. The system will take each traffic image as a separate input entity, process it, and then determine if it meets the requirements for sending it to the Traffic Density Identification Module (TDIM), which has two operating modes: Default and Special Mode. First, the module configures the parameter in Default mode.

II.EXISTING SYSTEM

[1] Technologies to Implement ITMS

2.1. Automobile Networks [3]

Inter-vehicle communication (IVC) or Vehicular Ad-hoc Networks (VANETs) are terms used to describe the direct communication between automobiles utilizing an Ad Hoc network. VANET has two channels of communication. Vehicles can communicate with one another on the road using vehicle-to-vehicle (V2V) technology. Vehicle-to-Infrastructure (V2I) communication allows vehicles to communicate with infrastructure installed beside roads. Each vehicle has an onboard unit (OBU), which is akin to the car computer but has additional features that enable VANET services and layers. An installed network of Roadside Units (RSU) serves as the infrastructure. The thematic architecture of VANET

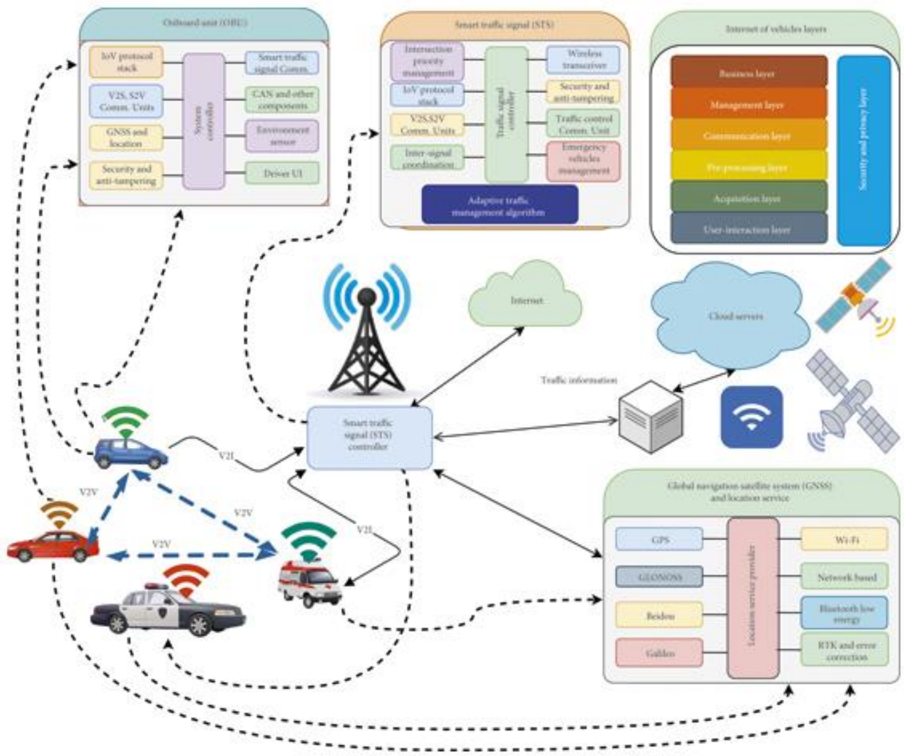


2.2. Architecture of the vehicular ad-hoc network (VANET)

The Internet of Vehicles (IV), which builds on the capability of VANET [1] and incorporates some characteristics of the Internet of Things, is the next generation of VANET (IoT). IoV supports a number of other communication services in addition to V2V and V2I. Figure 2 illustrates how the Internet of Vehicles (IoV) entails V2P (Vehicle-to-Pedestrian, allowing communication with vulnerable road users), V2S (Vehicle-to-Sensor, on the inside of the vehicle), V2H (Vehicle-to-Home, of the owner of the vehicle), V2B (Vehicle-to-Building, the surrounding buildings in the smart city), V2 (Vehicle-to-Road signs). The primary enablers of the next Intelligent Transportation Systems are IoV and VANET (ITS) [4]

III. INTELLIGENT TRAFFIC MANAGEMENT SYSTEM UNDER CONSIDERATION (ITMS):

The proposed Intelligent Traffic Management System's overall architecture (ITMS). All of the features and functional layers of IoV are carried over into the architecture. However, the Onboard Unit (OBU) is improved by the addition of a number of modules that are crucial for the ITMS's proper operation. A new element, the Smart Traffic Signal, has been added (STS). Together, these two elements work to deliver all the services needed from the ITMS. We describe each component in more detail in the following subsections.



3.1. Controller for Smart Traffic Signals (STS)

Smart Traffic Signal (STS) system must be installed in the middle of any intersection or corner. The elements listed below must be present,

(a) Intersection Priority M The management, which carries out the intersection's priority and is where this smart signal is located.

(b) The Internet of Vehicles (IoV) Protocol Stack is comparable to the previously described Onboard Unit. It's possible that not all features will be included in the STS. Included in this are V2G, V2S, V2H, etc.

(c) The Vehicle-to-Signal and Signal-to-Vehicle Communication Unit is employed for these types of communications (an additional communication protocol that is essential for exchanging messages between the vehicle and the STS)

The STS is in operation.

The smart traffic signal operates as follows:

Instead of the traditional three lights, the STS will broadcast the signals wirelessly via the S2V communication unit.

(ii) There is no need to install a GNSS receiver in the STS; its position can be programmed once by the engineer in charge of installation. However, if the STS is to be used as a GNSS/RTK error correction ground base station, it must include a GNSS receiving unit in order to calculate the error and send it to nearby vehicles in order for them to accurately calculate their location, speed, and direction.

(iii) The wireless transceiver allows the STS to communicate wirelessly with vehicles, collect nearby vehicle locations, and broadcast traffic.

(iv) The controller directs and manages the STS's operations. It makes a decision based on the adaptive algorithm, which will be discussed further below.

(v) At each intersection, the STS receives information from the waiting vehicles on each road. Vehicle UID from its certificate or any of the anonymous certificate's list if vehicle privacy is required, vehicle current position, vehicle speed, and vehicle moving direction are all collected. The STS collects all information and updates its internal database on a regular basis.

(vi) Based on the current road statistics obtained from the vehicle's information in the internal database, the controller executes the desired algorithm (details are provided in the following subsections) and determines which road must be avoided.

(vii) It should be noted that this paper does not cover pedestrian handling. This could be investigated further in future research.

3.2. Adaptive Traffic Management Algorithm

The Adaptive Traffic Management Algorithm (ATMA) is an essential component of the ITMS, designed to optimize the traffic signal according to the traffic density, minimize the waiting time, and maximize the flow rate. It uses the proposed architecture and features of IoV to collect essential information such as the number of waiting vehicles in the intersection, the waiting time of each vehicle, the vehicle type (normal, truck, or emergency), the flow rate of the open road, and the state of each road segment. The pseudocode of the main algorithm is defined in Algorithm 1, and the algorithm to select the next open road in the intersection is given in Algorithm 2.

Algorithm 1
Proposed adaptive traffic management algorithm.

Algorithm 1

Proposed adaptive traffic management algorithm.

Ectopic pregnancy

Inputs: $\mathscr{R}$, $\mathscr{L}(r)$, $\mathscr{T}_{g\min}$, $\mathscr{T}_{g\max}$, $\mathscr{T}_{r\max}$, $\mathscr{T}_{y}$, $\mathscr{T}_{\text{turnover}}$, $S\mathscr{L}_r$, d_{ir}, $\mathscr{D}_{\max}$ as defined in Table 3.

Initialize variables

(1) **For each** r in R

(i) **Set** $t_r(r) = \tau$ # set the closing time for the roads equals the current time

(ii) **Set** $\mathscr{V}(r) = 0$ # initialize the vehicle counts in all the roads

(2) **Set** $g_t = (\mathscr{T}_{g\min} + \mathscr{T}_{g\max})/2$ # initialize the Open Timer to the average of the minimum and maximum open timers

(3) **Set** $r_g = 1$ # Set the current open road to be the first one

(4) **Repeat forever:**

(5) **Calculate the number of vehicles in each road with the distance to the intersection** $< \mathscr{D}_{\max}$

\# To minimize the computation and iterating on a very large number of entries, we use the following approach:

(6) # For the open road, when a vehicle is crossing the intersection stop line $\mathcal{S}\mathscr{L}_{r_g}$ from any lane $\mathscr{L}(r_g)$,

(7) **Set** $\mathscr{V}(r_g) = \mathscr{V}(r_g) - 1$

(8) # For all the roads including the open one, on the arrival of any vehicle on the road r in any lane $\mathscr{L}(r)$,

(9) **Set** $\mathscr{V}(r) = \mathscr{V}(r) + 1$

(10) **If (no more cars are within** $\mathscr{D}_{\max}$ **in the open road):** # the open road is empty

(11) **Wait** for the transition time, $\mathscr{T}_y$

(12) **Close** the open road, r_g

(13) **Call** "Select Next Open Road" algorithm.

(14) **If (Emergency vehicle on a Closed Road** r_{em}**):**

(15) **Call** Handle_Emergency_Vehicle (r_{em}, r_g):

(16) **If** $\tau > (t_g + g_t)$: # When the green timer expired

(17) **Call** "Select Next Open Road" algorithm.

(18) **Inform** the vehicles about the currently open road

(19) **Periodically** send a broadcast message to all the roads: "the only road r_g having heading direction d_{r_g}" is open for at most g_t.

(20) **Continue** Repeating

End of the Main Algorithm.

Algorithm2

Select the next open road.

Algorithm 2

Select next open road.

Set$t_g = \tau$

(1) **Set**$t_r(r_g) = \tau$

(2) # **To prevent starvation**, find the road with the largest close time with the condition that it has vehicles, excluding those having no vehicles

(3) **Let**r_{lw} represents the road with the longest close time and initialize it to -1

(4) **For** x **in all the roads**$\mathscr{R}$:

(5) **if**$[\tau - t_r(x)] > \mathscr{T}_{r\,\max}$ and $\mathscr{V}(x) > 0$**then Set**$r_{lw} = x$

(6) **If**r_{lw} >= x, **then Set**$r_g = r_{lw}$**else Set**$r_g =$ argmax $[\mathscr{V}(r)]$ # select the road having the largest number of cars

(7) # now specify the green light time based on the number of cars

(8) **Let**$N_v = \sum_{i=1}^{i=\mathscr{R}} \mathscr{V}(i)$

(9) **Set**$g_t = (\mathscr{V}(r_g)/N_v \times \mathscr{T}_{\text{turnover}})$

(10) # **Adjust** the calculated green timer to be within the maximum and minimum allowed values for the open timer

(11) **If**$g_t > \mathscr{T}_{g\,\max}$**then Set**$g_t = \mathscr{T}_{g\,\max}$

(12) **Else if**$g_t < \mathscr{T}_{g\,\min}$**then Set**$g_t = \mathscr{T}_{g\,\min}$

End of "Select Next Open Road" algorithm.

Algorithm 3

Handle emergency vehicles.

Algorithm 3

Handle emergency vehicle.

To handle the situation when there is an emergency vehicle on a closed road

Inputs:

r_{em}: the closed road that has the emergency vehicle

r_g: the currently open road

(1) Send a warning message to all vehicles on the open road (r_g) that the road will be closed now due to the existence of an emergency vehicle on another road

(2) Wait for the transition time, $\mathscr{T}_y$

(3) Close the open road, r_g

(4) Open the road (r_{em}) having the emergency vehicle

(5) Keep that road (r_{em}) open until the emergency vehicle sends a message that it has crossed the intersection (overriding the $\mathscr{T}_{r\,\max}$ threshold)

(6) Wait for the transition time, $\mathscr{T}_y$

End of "Handle Emergency Vehicle" algorithm.

3.3. Traffic light controller [TLC]:

Merits of Intelligent traffic light controller using embedded system:

- Control the traffic.
- We can analyze the whole day's traffic using the log system.
- To reduce the possibilities of accidents.
- To reduce waiting time.
- To reduce the overhead of traffic police.

Demerits of Intelligent traffic light controller using embedded system:

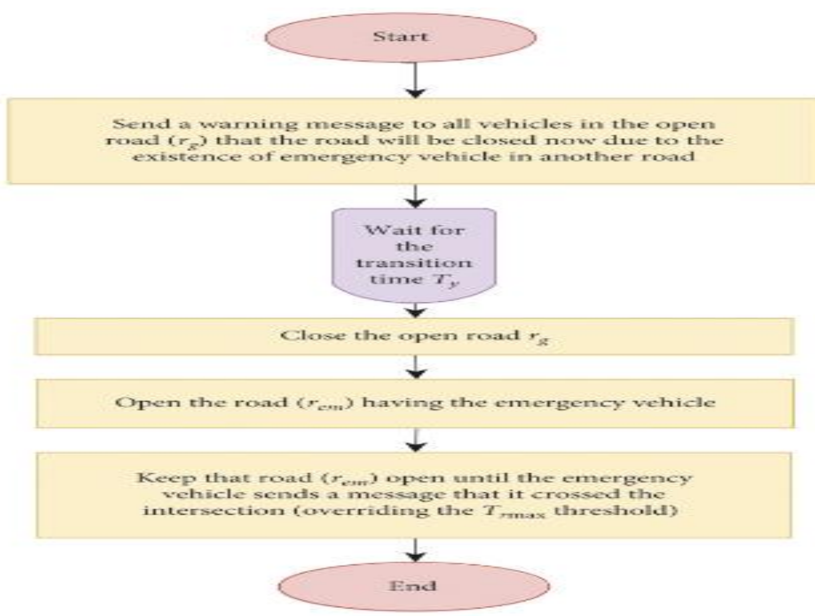
- We have to choose the correct position for sensors otherwise it will count any object as vehicle.
- Cost effective.
- Ineffective during heavy rain.

3.4. Stolen Vehicle Detection System [4]

In this module, for testing purposes, we compare the unique RFID tag read by the RFID reader to the stolen RFIDs stored in the system. If a match is found, then the traffic signal is immediately turned to red for a duration of 30 seconds.

IV. DISCUSSIONS

Flowchart of the overall proposed adaptive traffic management algorithm.



V.CONCLUSION

The modules can be implemented using the ITMS's design. An advanced application known as an intelligent transportation system (ITS) intends to give an innovative method of managing various modes of transportation and traffic management and to enable efficient traffic flow, more coordinated use of transportation networks for emergency vehicles. In a world with more vehicles than people, the Intelligent Traffic Management System outperforms any other control system. We can not only control traffic flow but also handle emergency vehicles such as police cars, ambulances, fire trucks, and so on. Stolen vehicles can also be detected using this IntelligentTraffic Management System. Future work directions may include extending the proposed algorithm for global traffic management, including the optimization of all the intersections in Smart Cities.

Future work could include expanding the proposed algorithm for global traffic management, as well as optimizing all intersections in Smart Cities. Furthermore, one of the possible important future works is dealing with pedestrians in intersections using Vehicle-to-Pedestrian (V2P) communication and wearables. This could include the creation of a new communication model called Pedestrian-to-Infrastructure (P2I). Another work direction is to use Deep Learning and AI in the optimization process for traffic management using each vehicle's current location, destination, and speed to provide better and more efficient traffic management.

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ARTIFICIAL INTELLIGENCE IN REVOLUTIONIZING SUSTAINABLE TEXTILE PRACTICES

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Abstract:

Artificial Intelligence has emerged as a transformative technology, driving innovation in various industries, including textiles. This paper explores the integration of AI in promoting sustainability within the textile sector. By analyzing applications such as smart manufacturing, waste reduction, resource optimization, and sustainable design, we highlight how AI contributes to reducing environmental impact. The challenges and future prospects of AI in this domain are also discussed. This study aims to provide a comprehensive understanding of how AI can revolutionize the textile industry to achieve sustainability goals.

Keywords: Artificial Intelligence, Sustainable Textiles, Smart Manufacturing, Resource Optimization, Circular Economy, Eco-friendly Innovations.

1.Introduction

The textile industry is one of the most significant sectors globally, playing a crucial role in the economic development of many countries. However, it is also a major contributor to environmental challenges, including excessive water consumption, chemical pollution, and substantial waste generation. The growing demand for sustainable practices in this sector has driven the exploration of advanced technologies to mitigate its environmental footprint. Among these, Artificial Intelligence has emerged as a powerful tool capable of transforming traditional practices into more efficient, eco-friendly, and innovative solutions.

This paper focuses on the applications of AI in addressing the sustainability challenges faced by the textile industry. By leveraging AI, companies can optimize resource utilization, minimize waste, enhance recycling efforts, and improve production processes. Moreover, AI-driven innovations are enabling sustainable design practices, supporting the industry's shift toward a circular economy. This study aims to explore these applications in detail while addressing the challenges and prospects of integrating AI into the textile sector’s sustainability efforts.

Objectives

- To explore the role of Artificial Intelligence in promoting sustainability within the textile industry.
- To analyze AI applications in smart manufacturing, waste reduction, resource optimization, and sustainable design.
- To examine case studies showcasing the impact of AI on reducing the environmental footprint of textile production.
- To identify the challenges faced by the textile industry in adopting AI technologies.

- o To discuss the future prospects of integrating AI with other emerging technologies for sustainable textile innovation.
- o To highlight the potential of AI-driven solutions in supporting the transition to a circular economy.

2. Applications of AI in Sustainable Textile Innovation

2.1 Smart Manufacturing

AI enables predictive analytics and real-time monitoring to optimize production processes. Machine learning algorithms help minimize energy consumption and material waste, while robotic automation enhances efficiency in textile production. Here are additional points detailing the role of AI in smart manufacturing:

- ➢ **Energy Management:** AI algorithms analyze energy consumption patterns and suggest optimizations to reduce electricity usage during manufacturing processes.
- ➢ **Automated Quality Control:** AI-powered vision systems detect defects in fabrics and garments in real time, ensuring high-quality standards and reducing waste.
- ➢ **Production Scheduling:** AI models optimize production schedules, considering factors such as order priorities, resource availability, and machine efficiency, to maximize throughput.
- ➢ **Customization and On-Demand Manufacturing:** AI-driven systems enable real-time customization, allowing manufacturers to create products tailored to consumer preferences while minimizing overproduction.
- ➢ **Supply Chain Optimization:** AI improves logistics and inventory management, reducing delays and ensuring materials are used efficiently in production.
- ➢ **Worker Safety Monitoring:** AI-powered wearable devices and monitoring systems enhance worker safety by predicting and preventing workplace hazards.
- ➢ **Real-Time Data Analytics:** AI tools provide actionable insights from production data, helping manufacturers identify bottlenecks and areas for improvement in real-time.
- ➢ **Sustainable Material Selection:** AI models suggest sustainable alternatives for materials during the manufacturing process to reduce environmental impact.
- ➢ **Robotic Process Automation:** AI-powered robots streamline repetitive tasks such as cutting, sewing, and assembly, improving precision and efficiency while reducing waste.

2.2 Waste Reduction and Recycling

AI facilitates advanced sorting techniques for textile recycling by identifying materials and separating waste efficiently. AI-powered systems also assist in designing closed-loop systems, supporting the circular economy. Here are additional points detailing the role of AI in waste reduction and recycling:

- **Material Recognition:** AI-based vision systems and sensors identify different types of textiles, such as synthetic fibers, natural fibers, and blended materials, improving the precision of recycling.
- **Automated Sorting:** AI automates the sorting of textile waste, segregating reusable and recyclable materials from non-recyclable waste, significantly reducing manual labor.
- **Textile Upcycling:** AI-driven algorithms suggest innovative ways to repurpose discarded fabrics into new products, promoting upcycling and extending product lifecycles.
- **Chemical Recycling Optimization:** AI models optimize chemical recycling processes by determining the most efficient methods for breaking down complex textile blends into reusable raw materials.
- **Waste Generation Forecasting:** AI uses historical and production data to predict waste generation, allowing manufacturers to plan and reduce waste at the source.
- **Real-Time Monitoring of Recycling Processes:** AI monitors recycling operations in real-time, ensuring efficiency and identifying bottlenecks that may hinder recycling effectiveness.
- **Designing for Recycling:** AI tools guide designers to create products with recyclability in mind, such as selecting mono-materials or easily separable components.
- **Circular Economy Analytics:** AI generates insights from lifecycle analysis (LCA) data to identify opportunities for circular practices in the textile industry.
- **Supply Chain Waste Minimization:** AI tracks material flow through supply chains, identifying excess or wasted materials and suggesting reductions.
- **Consumer Waste Management:** AI-powered applications educate consumers about textile recycling, recommending collection centers and sustainable disposal methods.

2.3 Resource Optimization

AI-driven models optimize the usage of water, dyes, and other chemicals, significantly reducing the environmental footprint of textile manufacturing. Here are detailed points highlighting AI's contributions to resource optimization:

- **Water Conservation:** AI-enabled dyeing processes and real-time monitoring systems reduce water consumption by up to 50%, ensuring efficient water usage in manufacturing.
- **Chemical Usage Optimization:** AI models analyze chemical combinations and suggest the most effective formulations, minimizing waste and harmful emissions.
- **Energy Efficiency:** AI tools monitor energy usage throughout production lines and recommend optimizations to reduce power consumption.
- **Material Utilization:** Machine learning algorithms optimize cutting and stitching patterns to minimize fabric waste during garment production.
- **Dynamic Resource Allocation:** AI dynamically adjusts resource allocations across production lines based on demand, reducing overuse and stockpiling of raw materials.
- **Supply Chain Resource Tracking:** AI tracks raw material flow through supply chains, identifying inefficiencies and ensuring optimal utilization at every stage.
- **Eco-friendly Material Integration:** AI models recommend eco-friendly materials and innovative blends that require fewer resources during production.
- **Wastewater Management:** AI-powered systems monitor wastewater from manufacturing processes, identifying contaminants and improving treatment methods.

2.4 Sustainable Design

Generative design powered by AI allows designers to create eco-friendly textiles by simulating the environmental impact of various materials and production methods. Here are more points on how AI facilitates sustainable design:

- **Material Impact Simulation:** AI tools simulate the environmental impact of various textile materials, enabling designers to make informed, sustainable choices.
- **Trend Forecasting:** AI analyzes market trends and consumer preferences, helping designers create on-demand products that minimize overproduction.
- **Customizable Eco-Designs:** AI generates customized designs tailored to sustainability goals, such as reducing fabric waste or using renewable materials.
- **Lifecycle Assessment (LCA):** AI tools perform lifecycle analyses of designs to estimate energy consumption, water usage, and carbon emissions before production.
- **Virtual Prototyping:** AI-powered virtual prototyping eliminates the need for physical samples, saving resources and reducing waste.
- **Closed-loop Design Strategies:** AI supports the creation of closed-loop products that can be easily recycled or repurposed at the end of their lifecycle.

3. Case Studies

3.1 AI in Dyeing Processes

AI has revolutionized dyeing processes in the textile industry, driving significant improvements in sustainability and efficiency. Below are detailed points on how AI contributes to dyeing innovations:

- **Dynamic Dye Formulation:** AI-powered algorithms analyze fabric types, production conditions, and dye properties to create precise formulations, reducing excess dye usage.
- **Water and Chemical Conservation:** Machine learning models optimize water and chemical usage during dyeing processes, resulting in up to 50% savings in resources.
- **Real-time Process Monitoring:** AI systems continuously monitor dyeing operations, detecting anomalies and adjusting parameters to ensure optimal outcomes with minimal waste.
- **Predictive Maintenance for Dyeing Equipment:** AI predicts potential equipment failures, ensuring uninterrupted operations and preventing resource wastage.
- **Color Matching Optimization:** AI tools automate color-matching processes, ensuring consistency across batches while reducing errors and rework.
- **Energy-efficient Dyeing:** AI minimizes energy consumption by recommending optimal temperatures and processing times for various materials.
- **Smart Dye Application:** AI-controlled robotic systems apply dyes evenly, improving fabric quality and reducing rework due to uneven dyeing.
- **Sustainable Dye Alternatives:** AI models suggest eco-friendly dyes and techniques, aiding the transition to greener alternatives.
- **Data-driven Decision Making:** AI platforms analyze historical data to identify patterns and recommend improvements for dyeing efficiency.

- **Integration with IoT:** IoT-enabled devices provide real-time data for AI systems, enhancing precision in dyeing processes and reducing resource wastage.

3.2 Smart Textile Recycling

AI-driven technologies are transforming textile recycling, promoting a circular economy. Key contributions of AI to smart textile recycling include:

- **Innovative Recycling Pathways:** AI suggests optimal recycling methods, such as mechanical, chemical, or thermal recycling, based on material composition.
- **Enhanced Fiber Recovery:** AI systems improve the extraction of reusable fibers from discarded textiles, increasing the value of recycled materials.
- **Predictive Analytics for Recycling Demand:** AI analyzes market data to predict demand for recycled textiles, helping companies align production with market needs.
- **Consumer Participation:** AI-powered apps educate consumers about recycling practices and connect them to nearby collection centers or recycling initiatives.
- **Lifecycle Tracking of Recycled Products:** AI tracks the lifecycle of recycled products, ensuring transparency and accountability in circular supply chains.
- **Cost Reduction in Recycling Processes:** AI optimizes resource allocation during recycling, reducing costs and improving efficiency.
- **Collaborative Platforms:** AI-driven platforms connect stakeholders across the recycling ecosystem, fostering innovation and shared solutions for textile waste management.

4. Challenges in Adopting AI for Sustainable Textiles

4.1 High Initial Costs

The implementation of AI technologies requires significant investment in infrastructure, training, and development, posing a barrier for small and medium enterprises (SMEs). Additional challenges include the high cost of acquiring and maintaining advanced AI-powered machinery and the financial risk involved for companies unfamiliar with these technologies. Access to funding and incentives can help alleviate these barriers.

4.2 Data Privacy and Security

AI systems rely on vast amounts of data, raising concerns about data security, intellectual property rights, and potential misuse of sensitive information. The lack of clear regulations around data usage and storage poses additional risks. Companies need robust cybersecurity measures and compliance with global data protection laws to address these challenges effectively.

4.3 Limited Expertise

The lack of skilled professionals to develop, implement, and manage AI systems in the textile sector limits its widespread adoption. The gap in AI literacy, combined with the absence of industry-specific training programs, creates hurdles for companies looking to integrate AI.

Collaborative efforts between educational institutions, industries, and governments can address this talent shortage by fostering specialized training programs and workshops.

5. Future Prospects

The future of AI in sustainable textiles lies in its integration with other emerging technologies such as blockchain and the Internet of Things (IoT). Blockchain can enhance transparency in supply chains, while IoT-enabled devices can provide real-time data for AI systems, further improving sustainability efforts. Collaborative initiatives between governments, academia, and industry players can accelerate innovation and adoption.

6. Conclusion

AI has the potential to revolutionize the textile industry by promoting sustainable practices and reducing environmental impact. While challenges persist, continued advancements in AI technology, coupled with supportive policies and collaborations, can pave the way for a greener and more efficient textile sector. The integration of AI in sustainable textile innovation is not just a technological upgrade but a necessity for achieving long-term environmental goals.

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A STUDY ON NATURAL DYE (PALASA PUSHPAM – BUTEA MONOSPERMA) ON JUTE-COTTON AND KHADI COTTON FABRIC USING MORDANT

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INTRODUCTION

Butea monosperma a sacred tree and native of the tropical and sub-tropical parts of India and South East Asia. The common names are Palash, Flame of the forest, and Parrot tree. The extract from the flower can be used as natural medicinal dye. Literature states that the flower can be used for skin disease and patients undergoing chemo-therapy. This flower can be explored for its dyeing qualities and medicinal values forproducing apparels for patients. Butea monosperma is a medium sized dry season deciduous tree, growing to 15m tall. The flowers are 2.5cm long, bright orange-red in color.

This study is focused on an exploration of the natural dye on khadi cotton and jute-cotton fabric with the following objectives:

- To collect and extract dye from Butea Monosperma
- To prepare the jute-cotton and Khadi cotton fabric for dyeing.
- To dye the fabrics using Butea Monosperma with natural mordants.
- To optimize the recipe and methods.
- To test the color fastness of the dyed samples.
- To analyze the results and find the scope for further studies.

METHODOLOGY:

MATERIALS USED FOR THE STUDY

Selection of the textile material.

Selection of the study material is an important step for the study. Khadi cotton and Jute-cotton fabrics were selected for the study because of their eco- friendliness, bio-degradability and their desirable properties.

Selection of Natural dye

Natural dyes are safe and eco-friendly. Natural dyes procured from natural wealth like plants, minerals and insects are fairly non-polluting and have unlimited scope to generate new shades.

Natural dyes are used in the conservation and repair of historic textiles, better biodegradability, and general higher compatibility with the environment. They also act as manure, enriching soil. Natural dyes have lower toxicity, are non-allergic and non-carcinogenic. It saves energy because the raw materials are not from petroleum.

Collection of the flowers (Butea monosperma)

The flowers Butea Monosperma bloom annually and therefore has to be collected and preserved for dyeing. The flowers are allowed to fall instead of plucking for full bloom. The Butea monosperma flowers were picked from the floor in the mornings without any impurities and were dried in the sunshade for ten days.

Drying of the flowers

The Butea monosperma flowers collected should spread out properly while drying. The flowers should be separated and dried in semi-shade condition. If the flowers are not spread out property, the clustering will allow fungus formation. Precaution should be taken to separate the flowers at intervals for thorough drying. The moisture content is very high in Butea monosperma flowers and therefore it is prone to fungal formation if allowed to cluster while drying. Drying can be done depending on the sunlight from 7 to 10 days. Butea monosperma flowers were preserved and used for dye extraction.

Selection of the mordant

Mordant are very important factor for dyeing.while dyeing with natural dye many mordant from natural and synthetic sources are available for this study. Mordant like Alum and Myrobalan were selected for this study reveal that these mordant give good color fastness and appearance.

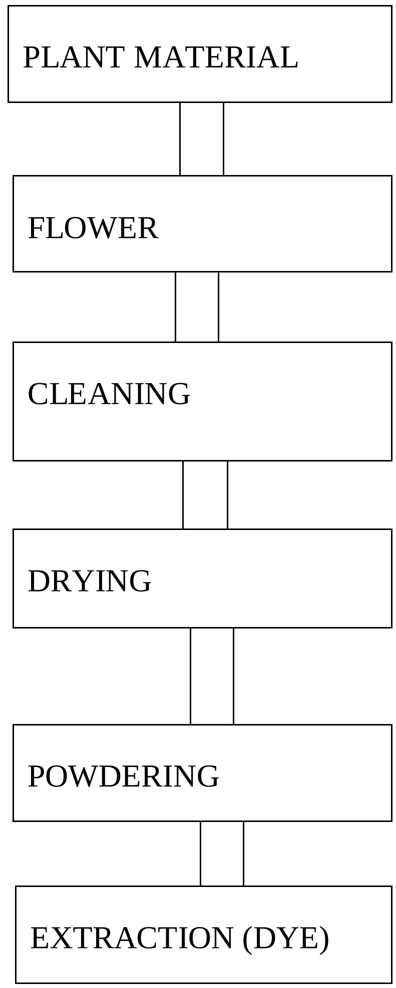
PREPARATION OF THE FABRIC

Bleaching

The study fabric (Jute-cotton) was bought with its natural colour, therefore bleaching was performed to remove its natural colour and to whitens the fabric. Bleached fabric will exhibit a consistent color after dying as a result of uniform dye uptake. Hence the fabric is wetted and treated with hydrogen peroxide, sodium hydroxide and sodium silicate solution for 45 minutes. After the fabric was bleached, the natural colour of the fabric was removed after washing with water.

EXTRACTION OF DYE

Flow chart for the extraction of dye



The selected dye plant Butea Monosperma flowers were cleaned. It was dried under shade and powdered well. This dye powder obtained from Butea Monosperma was used for extraction process.

DYEING OF ORIGINAL SAMPLE FOR THE STUDY:

Recipe:1 (Dyeing of Jute-cotton fabric)

- Jute-cotton fabric = 100gms (1/2 mts)
- Weight of the dye = 500gms
- Mordant Alum = 200gms
- Water ratio = 1:20
- Temperature = 100°c
- Time =1 hour

Dyeing procedure

Half meter of the bleached Jute-cotton fabric was taken and used for the study. The dye liquor with dye and mordant Alum was prepared for simultaneous mordanting and used as per the recipe given above. The Jute-cotton fabric was stepped into the dye liquor once when the dye bath was at 100°C and kept for 1 hour. The dye sample is then removed from the dye solution and rinsed thoroughly with water and squeezed and allowed to dry.

Recipe:2 (Dyeing of khadi cotton fabric)

Khadi cotton fabric = 35gms (1/2 mts)

Weight of the dye = 350gms

Mordant Alum = 140gms

Water ratio = 1:20

Temperature = 100°c

Time = 1 hour

Dyeing procedure

Half meter of Khadi cotton fabric was taken and used for the study. The dye liquor with dye and mordant Alum was prepared for simultaneous mordanting and used as per the recipe given above. The Khadi cotton fabric was stepped into the dye liquor once when the dye bath was at 100°C and kept for 1 hour. The dye sample is then removed from the dye solution and rinsed thoroughly with water and squeezed and allowed to dry.

ASSESSMENT OF THE DYE SAMPLE

TABLE - 1

VISUAL EVALUATION OF THE KHADI COTTON AND JUTE- COTTON SAMPLES – MORDANT – ALUM

S.No	Sample	General Appearance			Evenness of Dyeing			Texture			Brightness of Colour		
		E	G	F	ED	MD	UD	S	M	C	B	M	D
1	KCASM1	2	6	2	8	2	-	7	3	-	-	10	-
2	KCASM2	4	4	2	10	-	-	7	3	-	2	8	-
3	KCASM3	6	4	-	10	-	-	8	2	-	8	2	-
4	JCASM1	7	2	1	10	-	-	-	3	7	5	5	-
5	JCASM2	10	-	-	10	-	-	-	3	7	9	1	-
6	JCASM3	10	-	-	10	-	-	-	2	8	10	-	-

TABLE - 2

VISUAL EVALUATION OF THE KHADI COTTON AND JUTE- COTTON SAMPLES – MORDANT – MYROBALAN

S.No	Sample	General Appearance			Evenness of Dyeing			Texture			Brightness of Colour		
		E	G	F	ED	MD	UD	S	M	C	B	M	D
1	KCMSM1	2	6	2	-	8	2	8	2	-	-	7	3
2	KCMSM2	3	6	1	2	8	-	9	1	-	3	6	1
3	KCMSM3	6	2	2	8	2	-	10	-	-	8	2	-
4	JCMSM1	3	7	-	8	2	-	-	2	8	8	2	-
5	JCMSM2	8	2	-	10	-	-	-	2	8	9	1	-
6	JCMSM3	10	-	-	10	-	-	-	7	3	10	-	-

TABLE – 3

COLOUR FASTNESS OF THE DYED SAMPLE- WASHING

S.No	Sample	Colour Change	Grey scale Ratting
1	KCASM3	2/3	2/3
2	JCASM3	3	3

TABLE – 4

COLOUR FASTNESS OF THE DYED SAMPLE- PRESSING

S.No	Sample	Colour Change	Grey scale Ratting
1	KCASM3	4	4
2	JCASM3	5	5

TABLE – 5

COLOUR FASTNESS OF THE DYED SAMPLE- CROCKING

S.No	Sample	Crocking-Grey Scale Rating			
		25 cycles		50 cycles	
		Wet	Dry	Wet	Dry
1	KCASM3	4	5	¾	5
2	JCASM3	3/4	5	3	5

CONCLUSION

The performance of the study sample using the natural dye Butea Monosperma and the mordands Alum and Myrobalan was evaluated by doing the visual and colour fastness tests.

The visual evaluation of the samples using Alum showed good performance in both Khadi cotton and Jute-cotton fabric compared to myrobalan as mordant. Based on the performance of the study material dyed with Butea Monosperma using the mordants Alum and Myrobalan, it can be concluded that, the flower Butea Monosperma can be considered as one of the good sources for natural dyes that can be used on natural fibres for medicinal values.

The scope of further study of this research can be to explode natural mordants and mordanting techniques with Butea Monosperma dye. Different shades of orange can be achieved by varying the various aspect of the study. This natural orange colour dye can be recommended for the commercial product of fabric for apparels.

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SMART TEXTILES AND WEARABLE TECHNOLOGY: A PARADIGM SHIFT IN MODERN INNOVATIONS

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ABSTRACT

The convergence of textiles and advanced technology has given rise to an era dominated by smart textiles and wearable devices, transforming traditional fabric functionalities into dynamic, interactive platforms. These innovations include capabilities like health monitoring, environmental interaction, and seamless device integration. Smart textiles are categorized into passive, active, and ultra-smart types, each providing enhanced adaptability and usability. Wearable technology, from fitness trackers to AR/VR-integrated devices, has impacted industries such as healthcare, fashion, sports, and military. Despite facing challenges like durability, energy efficiency, and data privacy, advancements in artificial intelligence (AI), nanotechnology, and the Internet of Things (IoT) are unlocking groundbreaking applications. This paper explores the transformative potential of smart textiles and wearable technology in enhancing life quality and redefining industrial norms.

Keywords: Smart textiles, wearable technology, e-textiles, healthcare monitoring, IoT, nanotechnology, artificial intelligence, energy harvesting, AR/VR.

Introduction

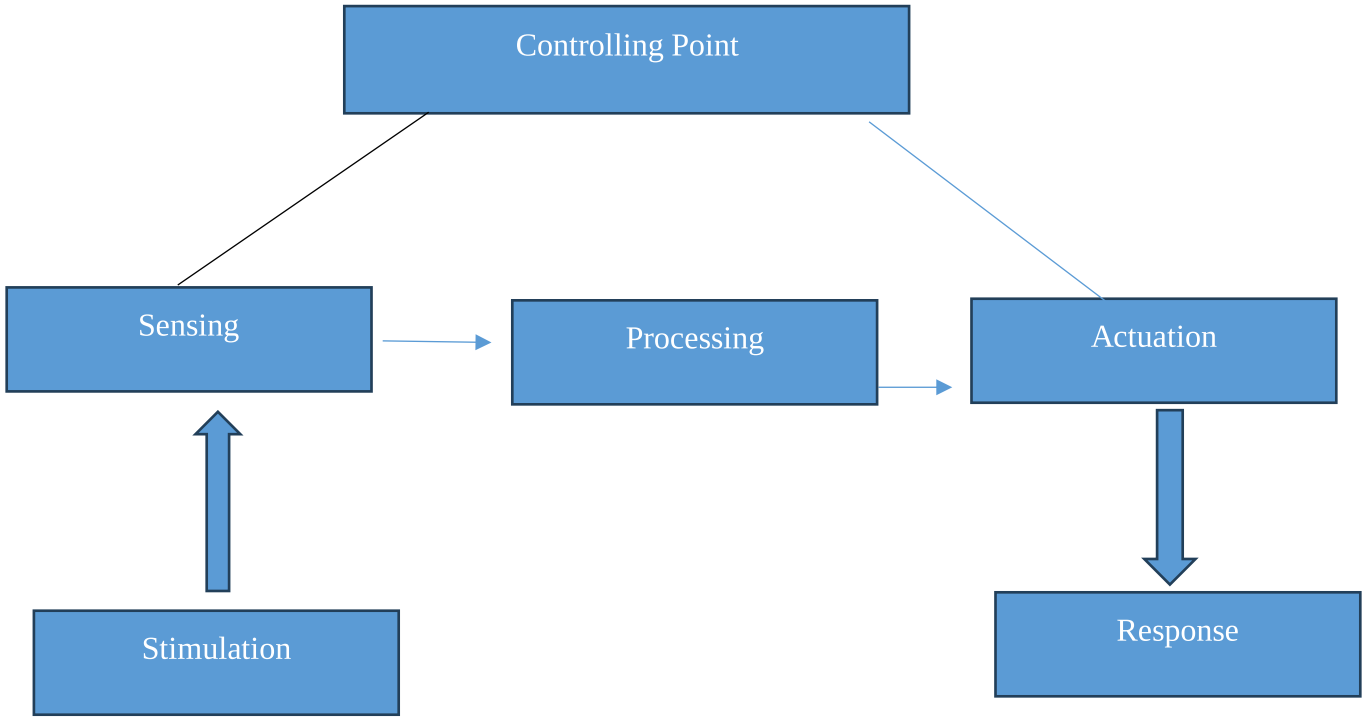
The fusion of technology and textiles has created a revolutionary field: smart textiles and wearable technology. These advanced materials and devices go beyond traditional fabric functions by integrating sophisticated features such as health monitoring, environmental response, and even energy generation. As technology continues to evolve, smart textiles are positioned to revolutionize healthcare, fashion, sports, military, and more.

What Are Smart Textiles?

Smart textiles, or e-textiles, seamlessly embed electronic components—like sensors, actuators, and conductive fibers—within fabric. Based on their functionality, they are divided into three categories:

1. **Passive Smart Textiles:** Capable of sensing environmental changes without reacting.
2. **Active Smart Textiles:** Equipped to sense and respond to stimuli such as pressure, temperature, or motion.
3. **Ultra-Smart Textiles:** Integrated with AI to learn, adapt, and make autonomous decisions based on user needs

Working Principle of Smart Textile



Smart textiles perform their full functionality through five key components:

1. Sensors – These capture parameters from the surrounding environment.
2. Data Processing – Essential for performing active processing when required.
3. Actuators – These responds based on the processed output from the sensors.
4. Stimulation – Derived from interactions with the environment.
5. Response Mechanism – The actuators provide the appropriate response to complete the system's functionality.

Advancements in Wearable Technology

Wearable technology consists of devices embedded in clothing or accessories, designed for seamless functionality and user convenience. Recent innovations in miniaturized electronics, wireless communication, and energy-harvesting systems have driven this field forward. Examples include:

- **Fitness Trackers and Smartwatches:** Devices like Fitbit and Apple Watch track physical activity, heart rate, sleep patterns, and more.
- **Smart Clothing:** Garments integrated with sensors to measure body temperature, posture, hydration, and other metrics.
- **AR and VR Devices:** Wearables like smart glasses enhance experiences in gaming, industrial training, and immersive environments.

Applications of Smart Textiles and Wearable Technology

Healthcare

- **Remote Patient Monitoring:** Smart textiles can continuously monitor vital signs such as heart rate, blood pressure, and glucose levels, enabling real-time medical intervention.
- **Rehabilitation:** Wearable devices provide feedback on movements, aiding in physical therapy and recovery.

Fashion and Lifestyle

- **Interactive Clothing:** Textiles that alter color, texture, or pattern based on environmental stimuli or user commands.
- **Self-Cleaning Fabrics:** Coatings with nanomaterials repel dirt and stains, ensuring long-term usability.

Sports and Fitness

- **Performance Metrics:** Wearables track metrics like speed, distance, and heart rate, helping athletes optimize training.
- **Sensor-Embedded Garments:** Compression wear that provides real-time feedback on muscle performance and recovery.

Military and Defense

- **Smart Uniforms:** Temperature-regulating and camouflage-adapting uniforms improve soldier efficiency and comfort.
- **Health Monitoring Systems:** Wearable devices track critical health data during missions.

Environmental Monitoring

- **Pollution Detection:** Smart textiles embedded with sensors can detect air pollutants or environmental changes.
- **Agricultural Applications:** Wearables monitor soil and crop health for sustainable farming practices.

Challenges and Limitations

Despite their immense potential, smart textiles and wearable technology face several challenges:

1. **Durability:** Ensuring fabrics maintain functionality through washing, wear, and exposure to environmental conditions.
2. **Energy Supply:** Developing efficient, lightweight energy sources like flexible batteries or energy-harvesting technologies.
3. **Cost:** High production costs hinder large-scale adoption.
4. **Privacy and Security:** Wearables collect sensitive data, necessitating robust security measures.

Future Prospects

The integration of AI, machine learning, and IoT is set to redefine smart textiles and wearable technology. Future advancements could enable fabrics to autonomously diagnose health issues, adapt to user preferences, or integrate seamlessly with smart ecosystems. Nanotechnology and sustainable material innovations will further enhance capabilities, making these technologies more accessible and environmentally friendly.

CONCLUSION

Smart textiles and wearable technology signify a transformative shift in how fabrics and devices function. Bridging fashion and functionality, these innovations offer unprecedented opportunities to improve quality of life, redefine industries, and address global challenges. With continued investment in research and development, the possibilities for these technologies are limitless.

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THE IMPACTS OF AI ON BUSINESS TRANSFORMATION AND DIGITAL INNOVATION IN COMMERCE: A STUDY

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Abstract

Artificial Intelligence (AI) has become a transformative force in business, driving significant changes in commerce through enhanced strategies, innovative operational models, and improved customer engagement paradigms. This paper delves into AI's role in advancing decision-making, optimizing supply chain management, and fostering personalized marketing. Additionally, it explores the ethical challenges and future directions associated with AI adoption.

1. Introduction AI has revolutionized industries globally, with commerce experiencing profound impacts. Businesses increasingly rely on AI to improve efficiency, establish competitive advantages, and enhance customer experiences. This paper examines how AI facilitates business transformation and digital innovation in commerce.

2. AI in Business Transformation AI contributes to business transformation in several ways:

2.1 **Automation of Processes:** AI tools streamline repetitive tasks, reducing costs and enhancing efficiency. For instance, chatbots manage customer inquiries, while robotic process automation (RPA) simplifies back-office operations.

2.2 **Data-Driven Decision Making:** AI systems process large datasets to provide actionable insights, supporting informed and strategic decision-making.

2.3 **Enhancing Supply Chain Management:** AI improves supply chain operations by predicting demand, managing inventory, and mitigating disruptions using real-time analytics and predictive models.

3. Digital Innovation in Commerce through AI AI drives innovation in commerce through:

3.1 **Personalized Marketing:** AI algorithms analyze consumer behavior to deliver customized recommendations, increasing customer satisfaction and loyalty.

3.2 **Dynamic Pricing Strategies:** AI enables real-time pricing adjustments based on demand, competition, and market trends.

3.3 **Virtual Assistants and Chatbots:** AI-powered virtual assistants offer 24/7 customer support, resolving issues efficiently and enhancing user experiences.

3.4 **Visual and Voice Search:** AI technologies like visual and voice search transform product discovery and purchasing processes.

4. Challenges and Ethical Considerations While AI presents numerous benefits, its adoption entails challenges:

4.1 **Data Privacy and Security:** Collecting and utilizing consumer data raises concerns about privacy and regulatory compliance, such as adherence to GDPR.

4.2 **Bias in AI Algorithms:** Unintentional biases in AI models can lead to unfair outcomes, necessitating rigorous ethical oversight.

4.3 **Job Displacement:** Automation can displace jobs in specific sectors, emphasizing the importance of workforce reskilling.

5. Future Trends AI's integration in commerce will evolve, with emerging trends including:

5.1 **Hyper-Personalization:** AI will enable deeper customer insights, allowing businesses to offer more tailored experiences.

5.2 **AI-Powered Sustainability:** AI can optimize resource use and minimize environmental impacts, contributing to sustainable practices.

5.3 **Augmented Reality (AR) Commerce:** AI-driven AR technologies will enhance online shopping, enabling virtual product trials.

6.The Impacts of AI on Business Transformation and Digital Innovation in Commerce

- AI is transforming commerce through strategic enhancements, operational innovation, and improved customer engagement.
- Key focus areas include decision-making, supply chain optimization, and personalized marketing.
- Challenges involve ethics, privacy, and future trends.

6.1. Introduction

- AI’s impact on industries, especially commerce, is profound.
- Businesses use AI to enhance efficiency, gain competitive advantages, and improve customer experiences.

6.2. AI in Business Transformation

- **Automation of Processes:**
  - Tools like chatbots and RPA streamline repetitive tasks.
  - Results in cost savings and operational efficiency.
- **Data-Driven Decision Making:**
  - AI provides actionable insights by analyzing vast datasets.
- **Enhancing Supply Chain Management:**
  - Predicts demand, manages inventory, and reduces disruptions via real-time analytics.

6.3. Digital Innovation in Commerce

- **Personalized Marketing:**
  - Analyzes consumer behavior for tailored recommendations.
- **Dynamic Pricing Strategies:**
  - Adjusts prices in real-time based on market conditions.
- **Virtual Assistants and Chatbots:**
  - Offers 24/7 customer support, improving user experience.
- **Visual and Voice Search:**
  - AI innovations enhance product discovery and purchasing.

6.4. Challenges and Ethical Considerations

- **Data Privacy and Security:**
  - Raises concerns about data handling and regulatory compliance (e.g., GDPR).
- **Bias in AI Algorithms:**
  - Unintentional biases lead to fairness issues, necessitating oversight.
- **Job Displacement:**
  - Automation affects jobs, requiring workforce reskilling.

6.5. Future Trends

- **Hyper-Personalization:**
  - AI will refine customer insights for even more tailored experiences.
- **AI-Powered Sustainability:**
  - AI optimizes resources and minimizes environmental impacts.
- **Augmented Reality (AR) Commerce:**
  - AI enhances online shopping through virtual trials.

6.6. Findings

- AI fosters innovation and growth opportunities in commerce.
- Overcoming challenges ensures businesses leverage AI to lead in digital transformation.

7. Conclusion AI is reshaping commerce by fostering innovation and creating opportunities for growth. Addressing ethical challenges and leveraging AI's potential will position businesses as leaders in digital transformation.

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ABOUT THE COLLEGE

Bon Secours College for Women is a Higher Educational Institution run by the Franciscan Sisters of Our Lady of Bon Secours. The college started in the year 2002 with a mere strength of 50 students. Now the college has grown up with a total strength of the 3419 students. The College is situated near Vilar village in a sprawling area of 16 acres. The location of college in a sylvan surrounding provides perfect atmosphere for learning. The college offers 20 UG, 12 PG, and 4 Ph.D., Programmes. There are more than 191 Diploma/Certificate/value added /Add-on courses have been offered in line with skill development and Entrepreneurship. On the whole Bon Secours extends its services towards the holistic development of the student community to transform them as Nation builders.

The College, Affiliated to Bharathidasan University is recognized by UGC under 2(f) and 12(B) of UGC Act 1956. The University Grant Commission conferred Autonomous Status upon the College, effective from the academic year 2024 for 10 years. The College was accredited by NAAC with A+ grade (CGPA 3.34) in first cycle on 24.09.2014 and A++ grade (CGPA 3.71) in the second cycle on 14.12.2021. The College was ranked in the 150-200 Band in National Institutional Ranking Framework (NIRF) 2024. The College is the Potential Mentor institution recognized by UGC under Paramarsh Scheme and extends its support for NAAC aspiring 5 Mentee institutions.

ABOUT THE CONFERENCE

An international conference is a large-scale event where individuals from different countries and organizations gather to discuss, present, and share knowledge on a specific topic or set of topics. These conferences are often organized by professional associations, universities, or international organizations and may serve academic, professional, or policy-oriented purposes. This conference brings together researchers, industry leaders, academicians, and technology experts to discuss cutting-edge innovations in fashion technology and their integration into e-commerce platforms.

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