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THE TEXTILE ASSOCIATION INDIA DELHI

The Textile Association (India) - Delhi

Presents

77th All India Textile Conference

Theme

Post Pandemic Global Vision of Textile Industry

16th & 17th March, 2024

at

Department of Textile & Fibre Engineering
Indian Institute of Technology (IIT)
Hauz Khas, New Delhi

Knowledge Partner
Prof. B K Behera
IIT Delhi

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THE NEW CHALLENGES FOR THE TEXTILE VALUE CHAIN

Wednesday, 31st January 2024

(09.00 am to 05.30 pm)

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The Textile Association (India), Mumbai Unit is organizing an international conference **"Sustainability and Circularity - The New Challenges for The Textile Value Chain"** on **Wednesday, 31st January 2024** at Hotel The Lalit, Mumbai.

In order to appraise the Indian Textile fraternity including the designers and the fashion schools about new circular sustainable model, The Textile Association (India), Mumbai Unit has planned this International Conference. We have made all-out efforts to cover most of the topics. This conference will be addressed by policy makers, reputed textile professionals and renowned experts from different parts of the world and India who are experts in the technologies. This high profile conference will be attended by 400 quality participants who will get the rare opportunity to listen to such high quality experts. We are sure that the participating delegates will be benefitted immensely from this conference and help them in conveying that sustainability and circularity is not a choice anymore but a necessity.

CHIEF GUEST: Mr. Virendra Singh, IAS, Secretary (Textiles), Cooperation, Marketing & Textile Dept., Govt. of Maharashtra

GUEST OF HONOUR: Ms. Roop Rashi (IA&AS), Textile Commissioner, Ministry of Textiles, Govt. of India

KEY NOTE SPEAKER: Dr. Naresh Tyagi, Head-Product Development & Quality Assurance, Madura Fashion & Lifestyle

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Topics & Speakers:

- **Farm & Forest Sustainability for Organic Fibre Production – Profitable one crop transition**
  Dr. Ajay Ranka, Chairman and Managing Director, Zydex Industries Pvt. Ltd.
- **Sustainable Textile Fibre's** - **Mr. Mayank Mody**, Director, Mody Linen Fibre Pvt. Ltd.
- **Traceability and Transparency** - **Mr. Amit Gautam**, Founder and CEO, TextileGenesis
- **Truetzschler's Approach towards Sustainability**
  Mr. Shiladitya K. Joshi, Dy General Manager - Product & Marketing, Truetzschler India Pvt. Ltd.
- **Sustainable Wet Processing of Textiles** - **Mr. Umasankar Sinha Mahapatra**, MD, Pulcra Chemicals India Pvt. Ltd.
- **Mr. Prashant M. Pote**, Customer Relations Manager-India, bluesign technologies ag
- Oerlikon Textile India Pvt. Ltd.

Panel Discussion: Achieving the UN Sustainable Development Goals (UN-SDGs)

Moderator: Ms. Chandrima Chatterjee, Secretary General, Confederation of Indian Textile Industry (CITI)

Members:

- **Mr. Murugan Thenkondar**, President & Global Head Marketing and Business Dvpt., Birla Cellulose, Grasim Industries Ltd.
- **Mr. K. Srinivasan**, Raw Material Specialist, IKEA Services (India) Pvt. Ltd.
- **Mr. Avik Banerjee**, Material and Components, H&M Group, Hennes & Mauritz India Pvt. Ltd.
- Lenzing Fibers

We appreciate your support to The Textile Association (India), Mumbai Unit in its activities and it is our pleasure to invite you be part of this event. Let us join hands to make this conference a great success.

Rajiv Ranjan	**G. V. Aras**	**V. C. Gupte**
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The Integration of Technology into Textiles

As we embark on a new edition of the **Journal of Textile Association**, I find it both an honour and a pleasure to extend my warmest greetings to our dedicated Advertisers, Contributors, Reviewers, and Readers. The textile industry has long been a dynamic landscape, shaped by technological advancements, sustainable practices, and evolving consumer preferences. I am excited to highlight some of the recent developments that have been instrumental in reshaping the fabric of our industry. The textile sector has witnessed a notable surge in sustainable practices. From the adoption of eco-friendly materials to the implementation of water and energy-efficient processes, our industry is making strides towards minimizing its environmental footprint. As climate change becomes an increasingly pressing concern, textile manufacturers are embracing innovation to create fabrics that not only meet high-performance standards but also adhere to stringent environmental norms.

The integration of technology into textiles has given rise to a new era of smart fabrics and wearable technology. The convergence of electronics with textiles has led to the development of fabrics that can monitor health metrics, regulate body temperature, and even generate energy. This interdisciplinary approach is opening up new possibilities for applications in healthcare, sports, and everyday life. Embracing the principles of a circular economy, the textile industry is actively working towards minimizing waste and maximizing the lifespan of products. Recycling and upcycling initiatives are gaining traction, as stakeholders recognize the need to move away from the traditional linear model of production and consumption. This shift towards circularity holds the potential to create a more sustainable and resilient textile industry. In an era of interconnectedness, collaborative efforts in research and development are becoming increasingly prevalent. Cross-border partnerships between academia, industry, and governmental bodies are fostering innovation and knowledge exchange. Such collaborations are essential in addressing global challenges, from developing new materials to finding solutions for ethical and social issues within the textile supply chain. The era of Industry 4.0 is reshaping the textile manufacturing landscape. Digitalization, automation, and the use of data analytics are enhancing efficiency, precision, and agility in production processes. This transformation not only streamlines operations but also facilitates the customization of textile products to meet individualized consumer preferences.

In conclusion, the landscape of the textile industry is undergoing a remarkable transformation, driven by a commitment to sustainability, technological advancements, and collaborative endeavours. The Journal of Textile Association is dedicated to serving as a platform for disseminating cutting-edge research and insights that contribute to the continued progress of our dynamic and evolving field. As we navigate these exciting developments, I extend my sincere gratitude to all those who contribute to the Journal of Textile Association (JTA). Your commitment to advancing knowledge and fostering innovation is truly commendable.

The New Year has started, **wishing you all a Prosperous New Year** as well as an insightful and rewarding reading experience.

Dr. Aadhar Mandot
Hon. Editor

T. L. PATEL, President

Vast Potential and Promising Future of Indian Textile Industry

T. L. PATEL, President

I am delighted to share the report highlighting the vast potential and promising future of the textile industry in India. With scope in new inventions, strong government support, emphasis on skill development, and water-saving techniques, the Indian textile sector is poised for significant growth and sustainability.

- **New Inventions:**

The textile industry is witnessing a wave of innovative developments that are redefining its prospects. Technological advancements like 3D printing, smart textiles, and nanotechnology have opened new avenues for creativity and efficiency. These inventions not only enhance the fashion and apparel segments but also play a vital role in technical textiles, medical textiles, and eco-friendly alternatives. India, with a rich heritage and skilled craftsmanship, can tap into these inventions to create unique products and become a global leader in textile innovation.

- **Government Support:**

The Indian government has recognized the immense potential of the textile industry and has undertaken various initiatives to foster its growth. Recent policy interventions such as the National Textile Policy, Pradhan Mantri Mudra Yojana, and the Technology Up-gradation Fund Scheme (TUFS) have aimed to provide financial assistance, promote ease of doing business, and encourage investments in the sector. Additionally, the 'Make in India' campaign has created a favorable environment for both domestic and foreign players to establish their manufacturing units, contributing to the industry's overall development.

- **Skill Development:**

In order to overcome the skill gap and enhance the employability of the workforce, skill development initiatives have gained significant importance in the textile sector. The government's Skill India Mission, in collaboration with industry associations, provides vocational training programs for various textile-related skills, including weaving, dyeing, printing, and apparel manufacturing. These initiatives not only empower individuals with desirable skills but also equip them to be valuable contributors to the industry, thereby boosting productivity and competitiveness.

- **Water Saving:**

Water scarcity is a grave global concern, and the textile industry has been under scrutiny for its water-intensive processes. However, the sector has recognized this challenge and is proactively adopting water-saving techniques and sustainable practices. Innovations like waterless dyeing, recycling and reuse of water, and wastewater treatment plants have significantly reduced water consumption and pollution in textile manufacturing. Such initiatives not only ensure environmental sustainability but also enhance cost-efficiency and brand reputation for textile businesses.

In conclusion, the textile industry in India is entering an era of unprecedented growth and transformative changes. With continuous advancements, government support, skill development, and sustainable practices, the sector demonstrates immense potential to become a global benchmark for textile manufacturing. It is crucial for stakeholders to embrace these opportunities and work together to maximize the industry's socio-economic impact while ensuring environmental stewardship.

Together, let us create a bright and sustainable future for the Indian textile industry.

Warm regards,

T. L. PATEL
President
The Textile Association (India)

Journal of the TEXTILE Association

FINISHING

Application of Eco-Friendly and Enzyme Based Stain Removers in Textiles

Harinder Pal*, Sagarika Pal & Nisha Jangra

Dept. of Fashion Technology, Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Sonipat, HR

Abstract:

The purpose of the study is to investigate the environmental impact of chemical stain removers, detergents, and review critically enzyme-based stain removers as an alternative to replace synthetic surfactants in textile industry. It also highlights some of the chemically based stain removers, which are eco-friendly and could be used as stain removers. Literature review reveals that the usage of enzyme-based products in industrial and household chores is growing day by day. Previous Research findings also indicate that enzyme-based products exhibit high efficacy in eliminating stubborn stains, while maintaining fabric integrity, which contributes to their popularity among environmental conscious consumers. Moreover, the adoption of these products can result in reduced water and energy consumption during laundry, leading to further environmental benefits. There are six kind of enzyme that are currently used in various industry; Oxidoreducers, Transferases, Hydrolysers, Lyases, Isomerizers, and Ligases. In these, hydrolysers enzymes like proteases, lipases, amylases, and cellulases are popularly used in washing industry. The paper discusses their mechanisms of action on stains and how it increases the rate of reaction. Overall, this review highlights the environmentally responsible choice of enzyme-based detergents and stain removers over conventional chemical-based alternatives. By replacing synthetic surfactants in the textile industry and promoting the utilization of eco-friendly stain removers, this study advocates for sustainable practices in cleaning and laundry, offering significant potential for reducing the environmental impacts associated with these processes.

Keywords: *Detergent, Environment, Enzyme, Mechanism, Surfactant, Stain Remover*

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1. Introduction

Environmental contamination caused by industrial activities is increasing day by day which have also increased the environmental conscious awareness among consumers. Washing products, such as laundry detergent, soap, and stain remover, can have both environmental and human health impacts which may be a cause of concern among users. These products contain a variety of chemicals that can be harmful to aquatic life, contribute to air pollution, and potentially cause health issues in humans. Aquatic life is frequently affected when detergents are dumped into natural water [1, 2]. Researchers have experimentally measured the harmful impacts of these chemicals and tried to find the eco-friendly solutions for the same. These detergents and stain removers contain such things as builders, surfactants, functional substances, dye transfer inhibitors, fragrance, phosphates etc. The harmful effects of phosphates as builders and surfactants as surface-active agents caused the most significant problem faced by the environment due to detergent industry. Phosphorus is a non-toxic chemical that acts as a plant nutrient [3, 4, 5]. Phosphates are primarily used in detergents to ensure efficient cleaning in hard water. According to the United States Environmental Protection Agency's national aquatic resource surveys, phosphorus is described as a "limiting nutrient," and the permissible limit of phosphate in detergent is 0.5%. Studies show that due to the excess use of this product, the phosphate level in soil, water bodies, rivers, underground water, etc. may increase [6]. Phosphorus can cause issues with water quality, including eutrophication and damaging algal development, when it is present in excess. According to David W. Litke [7] excessive use of phosphorus in fertilizer, manure, and laundry detergents is harmful and was prohibited in 1994. European Union introduced regulations and ban phosphates in domestic products in 2013 in a phased manner.

Synthetic surfactants are found to cause continuous foaming in rivers, sewage treatment plants, and around drainage discharges. Synthetic surfactants are very toxic and have low biodegradability. Bio-surfactants are possible replacements for synthetic surfactants as these cause harmful impact on the environment, including destruction of marine microbial communities, detriment to fish and other aquatic life, decreased capacity of photochemical power production in plants, and interference with wastewater treatment procedures. There is an immediate need for replacements of these harmful surfactants on a global scale, which are being used at the scale of 15 million metric tons per year, with 60% of those surfactants ending up in the aquatic system [8]. Wastewater that produced by domestic and industrial processes, such as washing clothes, yarn, fabric, and so on, is known as grey water. There is 50–80% of grey water produced by domestic activities, where the amount of laundry grey water represents 33%. This raw grey water is very harmful for soil. Grey water contains high quantities of sodium (Na) which promotes deterioration of soil condition and mobility. It also increases the pH level, which causes a high concentration of alkaline detergents when unclean grey

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water is used to fertilize land. Due to lack of awareness in implementing stringent rules and regulations in developing countries, they are found to discharge the grey water into the soil, which is not acceptable because it introduces pollutants like organic micro pollutants, chemical agents, and pathogens into fresh water and soil which affects humans via food chain [9].

In terms of human health, different cleaning substances represent different kinds of health risks. Some are linked to cancer's chronic or long-term impacts, while other poses acute or instant threats, including skin or breathing problems, watery eyes, and even chemical burns. People who have asthma, lung, or heart related problems should avoid using such chemical agents like ammonia and chlorine bleach because of their constituents has high acute toxicity. Many cleaners, including laundry detergents and fabric softeners, contain fragrances that can have immediate side effects on people such as hypertension, red eyes, sniffing, and lung discomfort. Cleaning products also pose a risk to the environment since many of them contain petroleum-based substances, which increase our reliance on foreign oil resources and contribute to the decline of non-renewable fuels [10].

To reduce the environmental and human health impacts of washing products, it's important to choose products that are environment friendly.

2. Stain and Stain Remover

A stain is the result of a chemical interaction between the staining substance and the fabric or finish. Because the chemical nature of every stain and substance is different, so therefore there is no particular solution or procedure for eliminating all stains. Stain remover refers to a product or chemical used to remove stains from clothing, fabric, or other washable materials. These products are designed to break down and remove specific types of stains, such as food, oil, ink, grass, and blood. Stain removers are available in various forms, such as liquids, powders, or sprays, and can be applied directly to the stain before washing or added to the washing machine along with the detergent. The effectiveness of a laundry stain remover may depend on the type of stain, the fabric, and the severity of the stain, among other factors [3,11].

2.1 Type and Mechanisms of stain remover

Since there is no particular solution or procedure for eliminating all stains, hence there exists several kinds of stain removers in market or at home in the form of natural and chemical based ingredients. Different stain removers works on different mechanism using different methods. Natural stain removers are eco-friendly and safe for humans as well as for animals. In this paper, a review on the different stain remover has been done and discusses different kinds of stain removers [3].

2.1.1 Eco Friendly Stain Removers

There are several kinds of are eco-friendly and natural stain-removers that can be used for removing stain from fabric, the briefing of which is mentioned below:

Baking Soda: Baking soda is a non-toxic and versatile cleaner. It has an abrasive texture that helps to loosen dirt and stains from fabrics. Baking soda also acts as a natural deodorizer, which helps to eliminate odors from clothes.

Vinegar: Vinegar is a cleaning agent that helps to remove stains, odors, and dirt from clothes. It has acetic acid, which is effective at breaking down dirt and grime. Vinegar is also an eco-friendly fabric softener, which helps to keep clothes soft and fluffy.

Lemon Juice: Lemon juice is a natural bleaching agent that helps to remove stains and brighten clothes. It is effective on mildew, rust, and other stubborn stains. Lemon juice also acts as a natural fabric softener [4, 11].

Hydrogen Peroxide: Hydrogen peroxide is a bleaching agent that helps to remove stains and brighten clothes. It is effective on blood, grass, and other stubborn stains. Hydrogen peroxide also acts as a disinfectant, which helps to kill germs and bacteria [14].

Cornstarch: Cornstarch is a natural and effective stain remover for greasy and oily stains. It works by absorbing the oils and grease from the fabric, making it easier to wash the stain away. To use cornstarch as a fabric stain remover, sprinkle a small amount of cornstarch onto the greasy or oily stain and let it be there for a few minutes [1].

These agents can be used in combination with each other or with traditional laundry detergents to provide effective cleaning results. It is important to test each natural agent on a small area of fabric before using it on the entire garment to prevent any damage or discoloration.

2.1.2 Chemical Detergents and Stain Remover

Stain remover and detergent are composed of various chemicals and solvents. These cleaning solutions are a mixture of builders, surface-active agents (surfactants), additives, and fillers [5]. Surfactant is a surface-active agent that aids in the reduction of surface tension and the enhancement of cleaning performance. Surfactants act as detergents, wetting agents, emulsifiers, foaming agents, and dispersants [15]. Builder is used as a softener to remove the heavy metals in the water. Additives enhance the washing power. Many components are added to the additives, like bleach, fragrance, optical brightener; stain remover, etc. [3, 2].

2.1.2.1 Mechanisms of Surfactant for Removing Stain

Detergent containing surfactants with emulsifying properties decreases its surface tension and increases the spreading and soaking capabilities of the water. Surfactants also aid in the

uniform penetration of the dye into the fabric during textile dyeing [2].

The heads of the surfactant molecules are hydrophilic in nature and the tails are hydrophobic. During laundry washing, the hydrophobic end of the surfactant is attached to the dirt particles on the fabric as shown in fig 1. When a sufficient amount of surfactant is added to the water, it creates micelles around the dirt. When micelles attach to dirt, their hydrophilic heads are drawn to water, and the fabric gets cleaned. Since only surfactant is not sufficient to clean and remove odors from laundry after washing so other components are also used along with it [16].

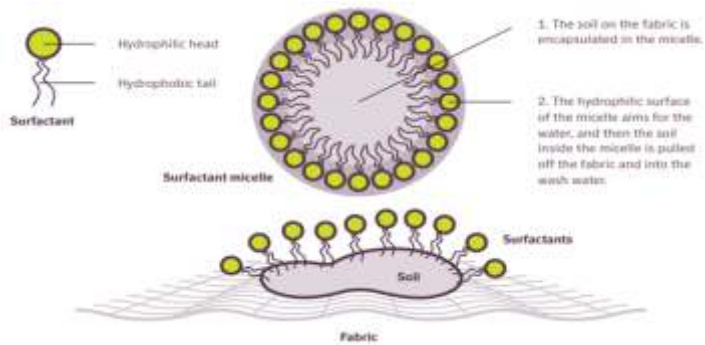

Figure 1: The function of a surfactant
Source: https://www.novozymes.com/en/campaigns/towards-100-biological-detergents

2.1.3 Enzymes Based Stain Remover

Enzyme is a biodegradable compound that helps to catalyze any chemical reaction in living and non-living creatures. This catalyst, which aids in increasing the rate of reaction to the desired level under physiological conditions, is known as "enzymes". It is beneficial in every stage, including industry, medical, laundry, textiles, baking applications, etc., where organic chemical reactions occur. It changes the whole process without changing itself [17]. Schwann extracted the first enzyme from an animal source, pepsin, in 1834 by acid extraction of the animal stomach wall [18]. In laundry industry, enzyme is mainly used to enhance the performance of stain removers and detergents at low temperatures. Its main function is to remove stains from fabric in an environment friendly manner and also performing other functions such as protecting cotton fibers.

According to Vitolo [19], enzymes are made up of a three-dimensional structure composed of a linear chain of amino acids. These amino acids help to find the catalytic activity of enzymes. At high temperature, enzymes lose their structure and catalytic capabilities. The efficient use of enzymes, particularly in industry, is dependent on striking equilibrium between the quantity of enzyme required, operating conditions, and reaction yields [20]. Enzymes are used in laundry detergents to dissolve protein, fat, or starch stains on clothing. Enzymes (proteases) were first introduced in laundry detergents in late 1960s. Nowadays, they are extensively utilized for their novel and varied capabilities [21].

There are six types of enzymes: Oxidoreductases, Transferases, Hydrolysers, Ligases, Isomerizers, and Lyases. According to Vitolo [19], Novozyme, which produces enzyme based products states that "Hydrolysers which dissolve protein, fat, and carbohydrate soils, are among the most commonly used detergents and stain remover enzymes. In one of the study, Novozymes [16] compared enzymes and surfactants to remove fabric stains. The study compared four different types of solutions with varying amounts of surfactant and enzyme to 36 different types of common daily stains. The study concluded that replacing enzymes with surfactants can improve stain removal on fabric while remaining eco-friendly and relatively inexpensive. Proteases, Lipases, Amylases, Manganese, Cellulose and Pectin are the most common types of hydrolyzing enzymes used in the textile laundry industry and detergent industry. According to recent research, multi-enzyme systems can replace up to 25% of a laundry detergents surfactant component without sacrificing washing effectiveness [22].

2.1.3.1 Enzyme Action

Enzymes are protein-based biological catalysts. Catalysts are substances that speed up chemical reactions while remaining unchanged themselves. Substrate is the chemical on which enzymes work. An enzyme and its substrate unite to produce an enzyme/substrate complex. In fig.2 when the process is finished, the complex degrades into products and enzymes, with the enzyme remaining unaltered [23].

e+s ⟷ es complex ⟷ ep complex ⟷ e+p

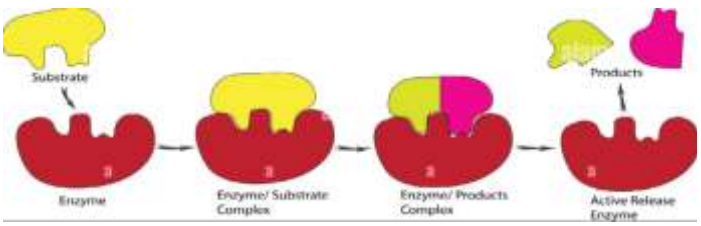

Figure 2: lock and key model of enzyme
Source: https://www.alamy.com/stock-photo/lock-and-key-enzyme.html?cutout=1&sortBy=relevant

The same thing happens with enzyme stain removers and detergents. They convert the complicated stain chain structure into a simple, water-soluble chain. Enzymes increase the rate of reaction 10 times [13]. It helps to balance the reaction between reactant and product. When the reaction begins, the reactant or substrate attains a much higher level of energy, which is referred to as the transition state in fig.3. The energy required in reaching a reactant or substrate in a transition state is known as activation energy. This energy acts as an impediment to the entire reaction. The catalyzed enzyme helps in lowering the activation energy, and the rate of reaction increases rapidly. The rate of catalyzed reaction is the same in both directions because the transition rate is the same in catalyzed reaction [18, 23].

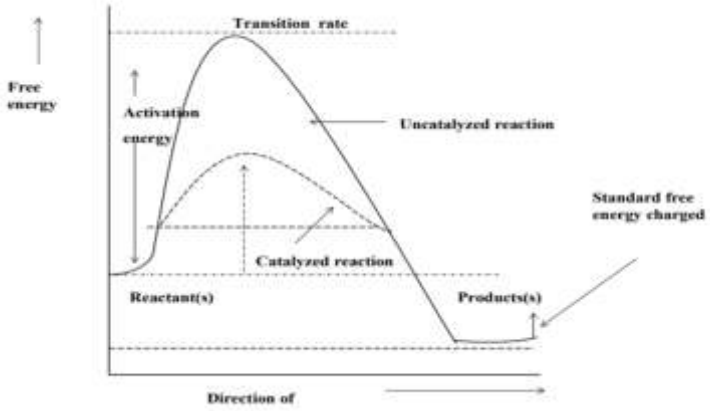

Figure 3: Need for energy in case of unanalyzed and enzyme catalyzed reactions
Source: https://www.scribd.com/document/210542816/EnzymeKinetics-by-P-C-Misra-Professor-Department-of-Biochemistry-Lucknow-University-Lucknow-226-007

2.1.3.2 Mechanisms of Enzyme for Removing Stain

Enzymes speed up the action of surfactants in laundry. Microorganisms produce enzyme products during fermentation processes. Proteins, which include enzymes, are easily biodegradable in the ecosystem. Starch and sugar, which are mostly produced by agriculture, are utilised as feedstock in the manufacture of enzymes. When enzymes break up stains, they behave like miniature Pac-Man characters as shown in fig 4. They break down the complex structure of stain into small molecule. Laundry stains can be more easily cleaned since molecules have smaller bits. Each kind of enzyme works best on particular kind of stain in laundry. For example, the lipase enzyme removes fatty and oily stains. Protease, which is the most important enzyme in laundry cleaning, helps remove protein-based stains very easily. The amylase enzyme removes a starch-based stain. The mannanase enzyme removes mannan-based stains like those in ice cream and yoghurt. On cotton fabrics, Cellulases enzymes are capable of removing protruding fiber ends, preventing fading, and preventing the development of "pills" after use and washing Novozymes [2, 13].

As per study done by Nova, it was reported that nine parameters influenced enzyme wash efficacy, which includes detergent composition, enzyme concentration, temperature, pH, water hardness, contact duration, type of dirt, type of wash system, and type of wash procedure.

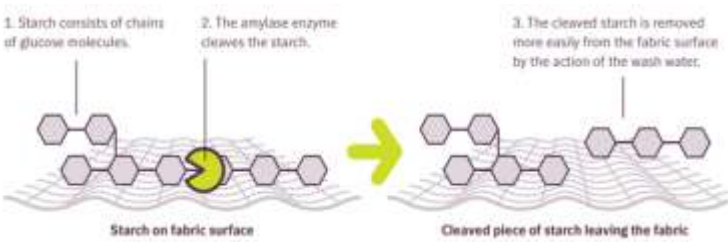

Figure 4: The function of an amylase enzyme
Source: https://www.novozymes.com/en/campaigns/towards-100-biological-detergents

2.1.3.3 Type of laundry enzymes

Proteases, Lipases, Amylases, and Cellulases are the four main categories of detergent enzymes, and each has its own advantages for use in laundry.

Proteases: The enzymes that are widely used in laundry detergents are proteases to remove protein based stains such as grass, eggs, blood, etc. [24]. Proteases are common enzymes found throughout nature [25]. The catalytic enzymes known as proteases or peptidases aid the hydrolysis of peptide bonds. They are present in all living things and also play a crucial role in both physiological and metabolic processes [17, 23]. There are several sources of protease enzymes which exist in plants, animals, and microbes [25]. Otto Röhm, a German scientist, originally developed proteases enzyme in 1913 as an active agent in laundry detergents for the removal of protein stains. Gerbruder Schnyder created the first commercial protease-containing detergent in 1959. Due to the growing awareness towards environment friendly technologies, proteases, especially alkaline proteases, represent a significant amount of promise for use in the detergent and leather industries [23].

Amylase: An enzyme called amylase is employed to break down the starch-based stain on the cloth. After proteases, amylases are the second most common enzyme used in the detergent business, making up 30% of total sales. The hydrolyses known as "amylases" (EC 3.2.1.1) work on the 1,4-glycosidic linkages of starch as well as other related molecules to produce a wide range of products, including sucrose, maltotriose, and corn flour. Animals, plants, microbes and bacillus species are the main source of amylases. Alpha and beta are the two categories of amylases; they attack the starch molecules in different ways [21]. Half of the enzyme market in the world is dominated by Bacillus species. Bacterial amylases are made using two different fermentation processes: submerged fermentation and solid-state fermentation. The ideal temperature for most bacterial amylase detergents is 20–60 °C, and the ideal pH range for bacterial detergent is 7.0–11.0. Around 30% of the world's detergent industries and 90% of the solid-liquid laundry use amylases, which are produced by the worldwide enzyme industry [26]. The necessity to provide a low-cost medium for increased production and the potential uses of amylase in a variety of sectors including detergents offers great opportunity for increasing amylase manufacturing [27]. Amylases, usually combined with proteases, help detergents clean dishes and fabrics. They are also employed in the sectors of institutional and industrial cleaning [23].

Lipase: In 1856, Claude Bernard discovered the first lipases, which dissolve the insoluble oil droplets and transform them into a soluble product, in the pancreatic fluid of a dead animal [28]. Lipases are present in all living things, including plants, animals or microbes, and the biggest source of the lipase enzyme is microorganisms. Long-chain fatty acid esters of glycerol are broken by hydrolyses known as lipases (EC 3.1.1.3) at the water-oil interface [30]. In a number of

processes, such as the conversion of triacylglycerol into diacylglycerols, monoacylglycerols, fatty acids, and glycerol, lipases function as catalysts between the aqueous and lipid phases [31]. Serine hydrolyses which are present in large amounts in lipases and are members of the triacylglycerol ester hydrolyse family [29]. The primary bacteria found in lipase detergent come from acinetobacter, bacillus, burkholderia, streptomyces, rhodococcus, pseudomonas, staphylococcus, aspergillus, cryptococcus, fusarium, talaromyces, and trichosporon [28]. After proteases and amylases, lipases are the third most common industrial enzyme. It was shown that phenylmethylsulfonyl fluoride which acts as an obstruction had an unfavorable effect on the activity of most lipase enzymes. Fermentation is a cheap medium for making the lipase enzyme. Submerged fermentation (SMF) produces a large contingent of extracellular enzymes. According to T. Asahii, yeast requires 32 hours of fermentation before producing the lipase enzyme [30]. For microbial detergent lipases, a pH range of 7.0–11.0 is suitable. The introduction of industrial microbial lipases by the detergent industry has been a game-changer for replacing harsh chlorine bleach with lipase and reducing industrial and sewage pollution in fresh water. Thermomyces lanuginosus was used to make the first commercially accessible recombinant lipase, known as lipolase, which was then expressed in Aspergillus oryzae. A. oryzae was used to produce the first commercial lipase that was isolated from trichoderma lanuginosus in 1994. They also manufacture the lipase-containing detergent LipoPrime® [28].

Cellulases: The enzyme known as cellulose breaks down the 1, 4-glucoside linkages in the cellulose chain. In ecology, Endoglucanases (EC 3.2.1.4), Exoglucanases (EC 3.2.1.91), or β -glycosidase are the three main types of cellulases that work together in a coordinated way to completely depolymerize cellulases to glucose (EC 3.2.1.21). They are created by fungi, plants, bacteria, protozoans, or animals and are found all over the natural world [23]. There are many negative effects seen on fabric texture and fabric strength due to the use of chemicals. The demand for the cellulases enzyme has increased rapidly these days due to adverse effects of different chemicals. Detergents employ Endoglucanases and Exoglucanases to improve cleaning, color brilliance, or fabric smoothing [32].

The removal of short fibers and surface fuzziness by the action of celluloses results in a smooth and glossy look, improved color brightness, increased hydrophilicity and moisture absorption. Cellulases usage also aids in softening clothing and removing debris that has become lodged inside the microfibrillar chain [33]. Few companies have also started producing cold-active celluloses. Among them are Novozymes, which creates Celluzyme and Celluclean; dyadic, which makes Rocksoft Antarctic and Antarctic LTC for use in the production of detergents; and Dupont, which produces Prima fast Gold, HSL Indige, and Prima Green to be used in the textile manufacturing industry [34].

3. Challenges faced by enzymes based stain remover and detergent

According to enzyme technical association [23, 35], Enzyme-based detergents and stain removers are generally considered safe and effective for removing stains and cleaning laundry. However, some potential harmful effects can occur with their use:

Effect on human body: Enzymes in detergents and stain removers can cause skin allergies, respiratory issues, and eye irritation. Caution is advised when using enzyme-based products to minimize the risk of these side effects.

PH levels: Enzymes have an optimal pH range at which they work best. If the pH is too high or too low, the enzymes may become denatured and lose their effectiveness.

Temperature: Enzymes are sensitive to temperature and can become denatured or degraded if exposed to high temperatures. Some enzymes work best at lower temperatures, while others require higher temperatures to activate.

Type of stain: Different enzymes work best on different types of stains. For example, protease enzymes are effective at breaking down protein-based stains like blood or grass, while amylase enzymes are effective at breaking down starch-based stains like food.

Concentration of enzymes: The concentration of enzymes in a detergent or stain remover can affect its effectiveness. Higher concentrations of enzymes can improve the product's ability to break down stains but may also make it more expensive [19, 21].

Overall, enzyme-based detergents and stain removers can have excellent durability, especially when used correctly and with the appropriate concentration of enzymes. However, the durability can vary depending on the specific product and the conditions in which it is used. It is important to use enzyme-based detergents and stain removers in moderation and to follow the instructions carefully to minimize these potential harmful effects. Additionally, it may be recommended to use natural alternatives or eco-friendly products when possible to mitigate the harmful effects to both humans and the environment.

4. Conclusion

Based on current review, it can be concluded that chemical-based detergents and stain removers have a negative environmental impact. These products often contain harsh chemicals that can be harmful to both the environment and human health and can contribute to water pollution, damage aquatic life, and contribute to air pollution. On the other hand, enzyme-based detergents and stain removers have a positive impact on both fabric and the environment. They are also biodegradable and do not accumulate in the environment, making them a more sustainable and eco-

friendly option. Studies have shown that enzyme-based products are effective at removing tough stains and are gentle on fabrics, making them a popular choice for consumers. Additionally, the use of these products can reduce the amount of water and energy needed for laundry, further reducing their environmental impact.

Overall, the use of enzyme-based detergents and stain removers is a more environmentally responsible choice compared to traditional chemical-based products.

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Journal of the TEXTILE Association

Cobots: Human-Robot Collaboration

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Abstract:

Human-Robot Collaboration is a new trend in industrial and service robots as part of the industry 4.0 plan. Robots and the approach are referred as the MRK (Mensch Roboter Kollaboration) in Germany and HRC (Human Robot Collaboration) in English. The primary objective of this novel method is to provide a safe environment for human-robot collaboration. There is a transition period between manual and completely automated manufacturing in which a human worker interacts with a machine. Due to safety concerns, this location has various constraints. Combining human talent and innovation with robot power and speed is necessary to overcome these enduring problems. Human-robot collaboration i.e. Cobots is becoming increasingly crucial in the age of automation and robotization. Only when the operational crew is not present in the machine's workplace is it permitted to operate automatically. Collaborative robotics opens up new avenues for human-machine collaboration. Personnel share the workstation with the robot, which assists him with non-ergonomic, repetitive, painful, or even dangerous procedures. The robot watches its motions with sophisticated sensors in order are not to limit, but more importantly, not to jeopardize, it's human partner. The emphasis in this paper is on the overview of collaborative robots, as well as its impact in the industry.

Keywords : *Cobots, Collaborative robot, Human Robot Collaboration, Industry 4.0, Industrial robot*

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1. Introduction

The COVID-19 pandemics have underscored the importance of resilient supply chains and effective collaboration between humans and machines within the workplace. Mandated measures like social distancing and periodic closures have compelled businesses to operate with minimal onsite personnel. Despite challenges such as labor shortages, supply chain disruptions, and production hurdles, businesses face continuous pressure to meet evolving customer demands. Integration of human ingenuity and innovation with the efficiency and speed of robots is imperative to surmount these persistent challenges. In this context, human-robot collaboration, known as collaborative robotics or "cobots", is increasingly vital in the era of automation and robotization. Their technology landscape is dynamically adapting to their preferences and behaviors, largely attributed to advancements in artificial intelligence algorithms. Cobots, or collaborative robots, are specifically designed to interact and cooperate with human operators. Particularly in the context of Industry 4.0, industrial cobots are anticipated to play a significant role due to their ability to operate safely and efficiently alongside humans. An exemplary instance is the universally authorized lightweight robot, LBR iiwa, developed by KUKA [1].

The core function of a cobot is to aid machine operators in their tasks, expanding automation opportunities and blurring the boundaries between cobots, traditional robots, and human roles. Initially conceived for direct physical interaction between machines and humans, cobots enable businesses to enhance production, swiftly adapt to evolving consumer preferences, and ensure the well-being of their workforce, clientele, and collaborators. Advancements in cobot technology encompass faster response times, precise movement algorithms, refined orientation abilities, and the capacity to emulate human actions. Notably, the progress in brain-computer interfaces represents an intriguing domain, potentially revolutionizing our interaction with robots. Accurate decoding and transmission of brain signals to robots could open up entirely novel approaches to collaborative work with robots.

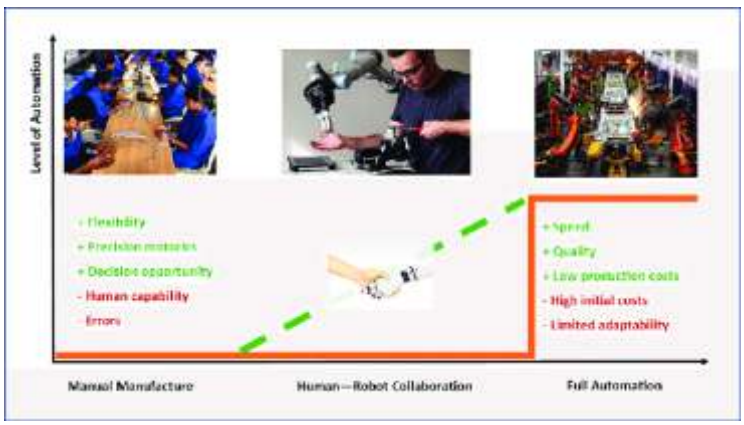

Figure 1: Standing of Human – Robot Collaboration [1]

2. History of Cobots

2.1 Industry 4.0

Industry 4.0 refers to the fourth industrial revolution. Numerous physical and digital technologies work together to bring about this shift. The primary elements of Industry 4.0 that textile sector first recognized center on the use of technology meant to computerize and automate operations, whose primary goals include raising productivity and lowering costs. By improving resource efficiency and productivity, industrial transformation primarily aims to boost businesses' competitiveness. Projects to use

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augmented reality, 3D printing, and simulation technologies in the textile, clothing, and apparel sectors are still in their infancy. Typically, these projects make use of tools and software designed to build new types of processes, goods, and business models. People see the benefits of Industry 4.0 implementation, such as a 15% reduction in energy usage, a 25% increase in work efficiency, more proactive decision-making, process optimization, and a better balance of work and life. Real-time communication, computer applications, carbon, fibres, health care, and sustainable development are developing and/or unknown sectors of Industry 4.0 in the textile business.

2.2 Robots to Cobots

When it comes to cobots vs. robots in manufacturing, the distinction lies in their purpose and, as a result, the type of duty allocated to these entities. Industrial collaboration robots are generally intended to work alongside humans to enhance human employees' job. They are not self-sufficient, but rather human-powered, and are utilized to boost production and effectiveness by providing extra strength, power, accuracy, and data. The main distinction is that cobots enhance the standard while robots replace them. Aside from that, cobots are simpler to develop and learn. Due to their size and strength, industrial robots are occasionally caged to safeguard employees from accidents. An industrial collaborative robot, on the other hand, may work on things like precise welding or quality assurance in the same plant.

Table 1: Comparison between traditional vs latest cobots [4]

	Traditional Industrial Robots	**Latest Cobots**
Flexibility	Fixed installation	Flexibly relocated
Price	Profitable (medium-large lot)	Profitable (small lot size)
Interaction	Rare interaction with worker,only if being programmed	Frequent interaction with the worker,even force/ precision assistance

General Motors (GM) introduced robots to operate side by side with people and contribute what each performed best amid industry clamor for better ergonomic working conditions. The eventual product was a class of robots that could carry a weight in its entirety but required human labour to transport it from one location to another. Since then, the use of cobots in the workplace has increased gradually. The three main jobs that cobots are used for most often include choosing and moving objects from one place to another, handling materials, and assembling. These operations will generate 75% of all cobot income over the next five years. Cobots often increase the chances to use automated processes rather than replacing or competing with robots.

Figure 2: Robot workplace with collaborative robot [1]

3. Balancing between Human and Task benefits

The need to assess the requirements for the implementation of cobots arose from the interest of management in industrial enterprises, which planned to introduce them as part of the expansion of the industrial park. About every job posting in an industrial context emphasizes the need for the employee to be innovative. As of now, the robots have failed to meet this condition. They lack the ingenuity and capacity to devise new and improved techniques. As a result, it is best to see the robot as a genuine coworker who may help to reduce the risk of workplace injuries [4].

There are two types of risk prevention assistance provided during the adoption of the cobot inside industrial processes. ISO (International Organization for Standardization) standards that are applicable are optional and guide the implementation process while avoiding mistakes and waste. Legislation, on the other hand, is binding and must be obeyed exactly as written. In a robotized workplace, safety regulations are defined with the goal of eliminating hazards by designing appropriate equipment, applying safety equipment (e.g., safety buttons or sensors), providing safety and health markings (e.g., warning signs), educating and training employees in production, programmers, and service personnel (training and practical exercises), and using personal protective devices [5].

Cobots are particularly useful when a person is required to be in close proximity to the robots. Person-robot partnerships in which a human instructs the robots, oversees the process, or even learns from the robots are examples of this. As the manufacturing labor matures, the complexity of operations on assembly lines rises, and the labour deficit persists, an increasing number of businesses are turning to collaborative robots, or cobots, to help fill the void.

When it comes to cobots and 5G networks, there is a natural match. Quality of service needs, which vary across time and context - think smart manufacturing - will be one of the major aspects of cobots. They give an example of cobots inside a manufacturing facility in their recent publication, with safety zones assigned to each cobot. A cobot in a facility without people does not require the same level of care as a cobot in close proximity to a person. As a result, in more safety-

critical contexts, the cobot require greater signaling, better bandwidth, lower latency, and faster decision-making capabilities through efficient computing [6].

Robots are already the answer to dangerous jobs, such as working with chemical, carcinogenic and toxic substances. Workers' perceptions of their work with cobots have been influenced by the current scenario, which is characterized by widespread transmission of infectious illnesses on the scale of an epidemic or even a pandemic.

A lot of study is being done to see how robots can mimic human motions and decisions. AI algorithms, on the other hand, have proven to be capable of discovering solutions that are superior to those developed by humans. This has been demonstrated in gaming strategies and design optimization difficulties. I believe it would be really intriguing to employ cobots to make human work more efficient, as well as to collaborate between humans and machines.

3.1 Types of Human Robot Collaboration

- Cobots are increasingly becoming a bigger part of the manufacturing pie, according to Joe Chudy, general manager at ABB Robotics. The dual-arm YuMi, single-arm YuMi, GoFa CRB 15000, and SWIFTI CRB 1100 cobots are available from the Zurich, Switzerland-based Robotics Company.

- The market for collaborative robots is predicted to rise at a CAGR [compound annual growth rate] of 17% betouren 2020 and 2025, with worldwide cobot sales increasing from an estimated $700 million in 2019 to over $1.4 billion by 2025, according to Chudy. [4]

- Japan-based FANUC Robots, widely regarded as one of the world's top industrial robot manufacturers, offers two lines of cobots: the FANUC CR series and the CRX Collaborative Robot Series. Worker training and research into further uses for cobots in production are two notable applications of FANUC's cobot robots.

- Some of the biggest challenges ahead include increasing the amount of weight collaborative robots can move and their range, said Campbell. He mentioned that the payload of the company's No. 1 model was recently boosted the UR10e, to 12.5 kg (27.5 lb.), a 25% increase. Cobots are used in manufacturing to work closely with humans on repetitive, painful or monotonous tasks, freeing humans for decision making and other difficult to program task. [5].

4. Categories of Cobot Scenarios

Categories divide tasks according to the relationship between cobots, operators, work pieces, and processes performed on the work pieces. These categorizations draw a clear line between the different skills required for cobots in different industrial scenarios. This is useful for programmers and researchers trying to set a work/research direction. The categories are [7]:

- Independent: Operators and cobots work independently on separate work pieces for individual manufacturing processes. The collaborative element relies on the coexistence of operators and cobots in the same workspace without fencing or protection. In other words, safety is achieved through the cobot's intrinsic safety and/or additional hardware/software safety elements. Therefore, the cobot are aware of the operator's presence and behave safely.

- Simultaneous: The operator and cobot work on different processes on the same work piece at the same time. There are no time or task dependencies between them. However, cobots must be spatially aware of operators and their task requirements in order to respect the operator's space. Processing work pieces simultaneously minimizes work piece transfer time between cobots and humans, improving productivity and space utilization.

- Sequential: Operator and cobot perform sequential manufacturing processes (P1 and P2) on the same work piece. Between the cobot and the operator there is a time dependency of the process. For example, the cobot treat her P1 of the work piece as input and allow the operator to proceed with her P2 of the work piece. In most cases, cobots are designed to take over tedious processes and improve working conditions for operators.

- Supportive: Operators and cobots work interactively towards the same process on the same work piece. There are dependencies between cobots and operator actions. In other words, you can't do another task without one. Collaborative robots must understand operator intent and task requirements in order to provide appropriate assistance. For example, an operator installs a screw in a toolbox while the cobot hold him. The cobot's role is to physically assist the operator in handling the work piece, improving ergonomics.

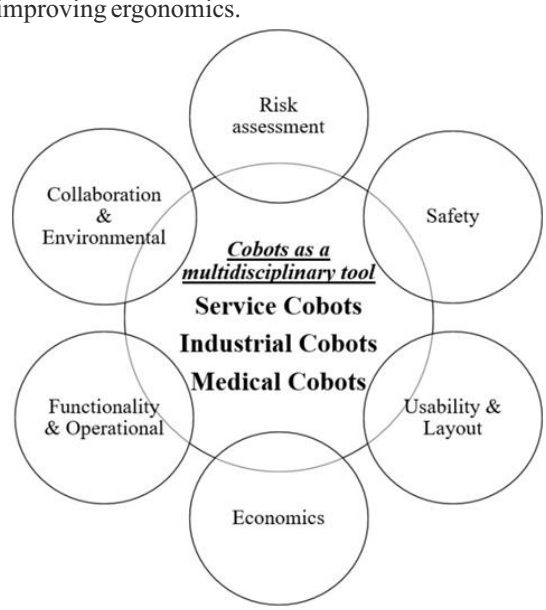

Figure 3: Cobots in manufacturing, service, and medical applications [1]

4.1 Cobots Communication

To work in teams and execute tasks smoothly and efficiently, humans rely largely on communication. Orders can be issued, intentions can be conveyed, and questions can be asked and answered. Communication signals are detected, recognized, and mapped to cobot activities. The modelling of the gesture is determined by whether it is static or dynamic. For a pose to be detected as a static gesture, its temporal length needs to exceed a specific threshold. In the case of dynamic gestures, the human pose sequence, sampled at a certain rate, is modelled as a time series (such as Hidden Markov Models, Recurrent Neural Network) which is then used for detection. Even with well selected gestures, having to memories and adhere to a predefined set of signals can be intellectually taxing and unintuitive for the operator. Allowing a person to speak with a cobot in his or her own unique manner leads to more effective, natural, and intuitive communication. The cobot can learn needed behaviors and relevant objects, states, and tools by asking the proper questions. Creating a natural language system is difficult since the operator's language use changes dramatically as the task continues [8].

In a collaborative task where only verbal communication is allowed, the frequency of morphemes decreases as the number of task trials increase. This is because individuals naturally begin to release words as they grow acclimated to the activity. They automatically begin to evaluate and accommodate their teammates' requirements without those demands being expressly articulated. As a result, any language model between a human and a cobot should account for changes in human language as the human grows more acclimated to the task. Using multi-modal communication can outperform single mode communication. It can also be redundant, such as a voice and gesture system that responds to the same instruction. Before deciding how to adopt multimodal communication, it is critical to examine whether or not it is required. A gesture would only be required, for example, if numerous things with the same verbal description were in close proximity [9].

After specifying a communication guideline, the permissible communicated signals must be mapped to executable cobot actions, i.e., a signal should be made a command. This can be done manually or through learning. An operator can participate in the signal-action mapping through interactive learning. However, in an industrial setting when insufficient variety in mapping is expected, this might introduce unneeded complexities. This allows the cobot to begin operating on the item before an explicit command is sent. This is particularly useful when the communication channel domain is continuous, such as gaze direction, and requires segmentation before mapping. Thier job can be used to direct and initiate communication only when needed. This increases efficiency and reduces the chance of error and confusion.

After defining the communication policy, you need to map the permitted communication signals to possible cobot actions. In other words, the signal should be a command. This can be done manually or by learning. Programmers manually assign gestures to cobot actions based on task needs. Using interactive learning, operators can play a role in signal-action mapping. Even with well selected gestures, having to memories and adhere to a predefined set of signals can be intellectually taxing and unintuitive for the operator. Allowing a person to speak with a cobot in his or her own unique manner leads to more effective, natural, and intuitive communication. The cobot can learn needed behaviors and relevant objects, states, and tools by asking the proper questions. Creating a natural language system is difficult since the operator's language use changes dramatically as the task continues.

However, this may present unnecessary complexity in an industrial environment where poor variability in imaging is expected. This helps cobots react to objects before issuing an explicit command. This is especially useful when the communication channel domain is contiguous. Line of sight, segmentation is required before mapping [10].

4.2 Impact of Cobot Development

Furthermore, cobots make a lot of decisions in real time, and the search space might be quite big. This necessitates traversal of vast knowledge graphs, which necessitates processing power, a dependable network, and unique software structures. However, current advancements in technologies like as linked data, parallel processing, edge computing, and distributed artificial intelligence enable cobots to make optimal decisions, resulting in robust and efficient execution.

The difficulties of deploying cobots at scale Massive deployments of any new technology are a chicken-and-egg dilemma, as industries must establish use cases for cobots. All robotic automation in the past has been set up and fine-tuned during the design stage. In the ideal instance, it has been modified at run-time using a data-driven strategy. Cobots provide process designers the chance to train cobots to carry out tasks and actively grow at run-time, allowing for advances through artificial intelligence. The technology is available, but in order to achieve enormous deployments at scale, the use cases must be established at scale.

A problem with the market adoption of cobots is that insufficient technological development makes it difficult. Technology used in cobots comprises hardware design, sensors, actuators, effective information processing, video processing, planning, and several artificial intelligence-related domains, as well as technologies that provide safety, predictability, and the solution's security [11].

Ø Trust: When a technology becomes reliable, it spreads rapidly. People put tape on microphones or laptop cameras when they don't trust their device or programme.

Similarly, we would be hesitant to engage with industrial robots if we did not trust them.

Ø Reliability: The difficulties of deploying cobots at scale massive deployments of any new technology are a chicken-and-egg dilemma, as industries must establish use cases for cobots. Although the technology is already in place, large-scale use cases still need to be developed before they can be deployed.

Ø Safety: Insufficient technological maturity is a barrier to cobot market deployment. Cobot technology encompasses hardware design, sensors and actuators, efficient information processing, video processing, planning, and a variety of disciplines from artificial intelligence landscapes, as well as technologies that ensure the solution's safety, predictability, and security.

5. Merits & Demerits of Cobots

According to ABI Research (global technology intelligence firm) , the worldwide cobot market is expected to grow at a CAGR of 32.5% from USD 600 million in 2021 to USD 8 billion in 2030. To lower costs, shorten time- to-market, and meet expanding customer demands, modern production necessitates excellent human-machine collaboration.

It's important to note that the advantages and disadvantages of cobots can vary based on specific use cases, industries, and applications. Additionally, advancements in technology may address some of the demerits over time.Here's how cobots can help manufacturing companies [8].

Aspect	Merits (Advantages)	Demerits (Disadvantages)
Safety	- Designed to work alongside humans, reducing the risk of injury.	- May still pose some level of risk if not properly programmed or maintained.
Productivity	- Enhances productivity by automating repetitive and mundane tasks.	- Initial setup and programming may require time and expertise.
Flexibility	- Easy to program and reprogram for different tasks and workflows.	- Limited payload and speed compared to traditional industrial robots.
Collaboration	- Can work in close proximity with humans, fostering collaboration.	- Limited payload capacity compared to traditional robots.
Cost	- Generally more affordable than traditional industrial robots.	- Upfront costs can still be high for small businesses or startups.
Ease of Use	- Intuitive and user-friendly programming interfaces.	- Requires training and skilled personnel for programming and maintenance.
Space Requirement	- Compact and can operate in small workspaces.	- May require additional space for safety measures and peripheral equipment.
Adaptability	- Easily adaptable to changing production needs.	- May require upgrades or modifications to handle new tasks.
Integration	- Compatible with existing systems and machinery.	- Integration into existing processes may require customization and adjustments.
Maintenance	- Generally low maintenance compared to traditional robots.	- Specialized maintenance and occasional downtime for updates and repairs.

6. Application of Cobots in Apparel Industry

The low entrance threshold of a cobot's cell makes it appealing. The investment is cheaper than that of a robot cell. Cobot is perfect for obtaining experience in Automation and even programming knowledge are not required. For instance, many products are relatively inexpensive in the assembly and packaging industry. Even in a clean working environment where the Picking and placement are the only acts that cobot can perform very well. However, the lack of adaptability remains an issue. It paints a picture of future cyber-physical operations that merge robots, cobots, and people to maximize productivity and quality, while minimizing overall costs. Cobot performance and learning may be enhanced using AI and machine vision. A variety of functions are offered by intelligent cobot vision systems, including item location and identification, barcode and totem interpretation, pattern matching, and colour recognition. The cobot may be instructed in new procedures and guided from position to position using hand gestures enabled by the vision system. In other instances, machine operators may rapidly and effectively train cobots utilizing a tablet computer and a drag-and-drop flowchart-based approach. Cobots can be adapted to a variety of production procedures, such as machine tending, screwdriving, and dispensing. CNC (computer numerical control) machines, stamping and punch presses, various cutting machines, and injection molding stations are among the machine tending tasks where cobots can relieve people from repetitive and potentially dangerous activities. Inspecting finished parts or products is another area where cobots with machine vision can excel. If the part is complex, a thorough inspection may require high-resolution images from various angles requiring the coordination of multiple stationary cameras. Alternatively, a cobot with a single camera can identify the part being inspected and move around the part accordingly, capturing all the needed images for a complete visual inspection [14].

7. Future Scenarios – Collaboration of Man and Machine

Industry 4.0 opened the way for data-driven technologies like IoT, cyber-physical systems, wearables, AR, cloud computing, artificial intelligence, cognitive computing, and so on to power automation and smart manufacturing. Though Industry 4.0's only goal is to enhance process efficiency through physical and digital integration, it inadvertently overlooks the importance of human value in process optimization. By merging the responsibilities of mechanical components and human employees in manufacturing, Industry 5.0 refocuses on human value. As a result, cobots will form the fundamental core of the next wave of the industrial revolution, known as Industry 5.0. According to Universal Robots of Denmark, cobots are at the core of Industry 5.0. Cobots may be utilized as a plug-and-play solution in a wide range of manufacturing and industrial processes, including automobile production, food processing, chemical plants, medical devices, and kits [13].

However, present technologies are simply a first step in the field of human-robot interaction. As Artificial Intelligence research advances, the programming of Cobots will most likely become considerably simpler, if not obsolete, in the future. Cobots may revamp a company's whole manufacturing process "A cooperative robot" may impact several processes in an appropriate manner and manage a gain in efficiency of at least 30 to 40%." The Increased production, but also by a reduction in worker and sick leave is, nonetheless, It is impossible to determine the precise amount of efficiency boost obtained by cobots because might differ widely from one firm to the next and from one sector to the next.

"Automation and the cost of robotic technology might soon be comparable with low-wage jobs." The ramifications for garment assembly employees if machines replace them on a broad scale, the implications for industry and underdeveloped countries would be significant. As the world's population grows to an anticipated 9 billion people by 2030, the garment industry is predicted to quadruple in scale to a $4.4 trillion enterprise with regional manufacturing clusters growing to new consumer markets. Just as in past industrial revolutions, when factory owners embraced new technologies, technology to gain a competitive edge in their businesses, it is incumbent on today's businesses to invest in the education of tomorrow's workforce."

Cobots will complement intelligent decision-making since they work well with people in a safe setting. Boost the market for high-quality products, allow for mass customization and personalization reduce production costs, create new job titles (for example, Chief Robotics Officer), and increase virtual schooling to take use of collaborative robots [14].

- Service providers must be prepared to deliver consistent, differentiated quality of service via their networks. Because application safety and predictability requirements (in this example, cobots) propagate requirements on network infrastructure, service providers will need to provide a specific quality of service in safety-critical scenarios.
- Technology suppliers will need to guarantee that the systems are trustworthy in terms of predictability, security, and safety. They must also guarantee that rules and standards are followed.
- As this technology evolves, businesses will need to find use cases that profit from human-robot collaboration.

8. Conclusion

In conclusion, a cobot is particularly well suited as an entry-level automation model for businesses that have minimal expertise with technology and robotics and/or have limited budgets. The potential of using without safety boundaries, a robotic workplace may be tempted to be completely utilized. Products that are automated in order to reduce installation space as well as the expenses of safety barriers. It is feasible in some circumstances to be content with the cobot's poorer machine efficiency and dearth of features—features that a loading robot might in fact provide. Everything is based on how the business is run. But sooner or later, businesses in the machining sector frequently make the move to a loading robot.

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PROCESSING

Comparative Analysis of Antibacterial Property of Bamboo Fabric Treated with Calotropis gigantea and Psidium guajava leaf extract

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Abstract

In this study two environmentally favourable herbs, Calotropis gigantea (C. gigantea or commonly known as Aakada) and Psidium guajava (P. guajava or commonly known as Guava), were extracted in methanol and used as antibacterial agents. Bamboo fabric was pretreated with harad (Terminalia chebula) as pre-moderating agent. The extract of P. guajava and C. gigantea were applied to the pretreated bamboo fabric in different concentrations of bioactive compound (100µg/mg of fabric (10.0 % own weight of fabric (owf), 50 µg/mg of fabric (5.0% owf), 25 µg/mg of fabric (2.5%), 12.5 µg/mg of fabric (1.25%)) by Spray-dry-cure process at 50±2 °C.

Bamboo fabric treated with Calotropis gigantea at 12.5 µg/mg of fabric weight showed 99.5 % and 87.6% antibacterial activity against Staphylococcus aureus (S. aureus) and Escherichia coli (E. coli) respectively. While Psidium guajava leaves extract shows 99.16 % antibacterial effect for S. aureus &.67.66% for E. coli for 50 µg/mg of fabric of fabric.

Keywords: *antibacterial activity, Bamboo fabric, Calotropis gigantean, Psidium guajava, Terminalia chebula*

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1. Introduction

Psidium guajava L. (guava), a fruit plant belonging to the family Myrtaceae, is found all over the world. Guava leaves, roots, and fruits have been used for the prevention and treatment of diarrhea [1, 2]. In several studies, guava showed significant antibacterial activity against common food borne diarrhea-causing bacteria such as Staphylococcus spp., Shigella spp., Salmonella spp., Bacillus spp., E. coli, Clostridium spp., and food spoilage bacteria such as Pseudomonas spp. [2-5].

C. gigantea is a widely growing plant native to India, Indonesia, Malaysia, Philippines, Thailand, Sri Lanka and China, commonly known as milk weed or crown flower weed. C. gigantea is latex bearing plant and release the latex after a tissue injury. Plant latex is a mixture of alkaloids, tannins, gum, sugars, starch, resins and protein [20].
The focus of this investigation was to determine antimicrobial activity of C. gigantea and Psidium guajava L. against pathogenic microorganisms for bamboo treated sample in vitro testing.

A variety of textile items finished with antimicrobial finish created a greater awareness of the clean lifestyle practiced by the current generation. The inherent properties of textile fibres and the structure of the substrate favor the growth of microorganisms. When the fabric is worn close to the skin, cross-infection by pathogens results in the development of odor.

Regenerated bamboo fabric, also known as bamboo viscose or bamboo rayon, is a textile material produced from bamboo cellulose. Bamboo fabric itself has inherent antimicrobial properties due to the presence of a substance called "Bamboo Kun" Bamboo Kun is believed to provide resistance to bacteria and fungi, inhibiting their growth on the fabric's surface [6].

Antimicrobial agents can be found in extracts from a variety of medicinal plants and herbs, including leaves, stems, flowers, fruits, roots, seeds, and bark. These antimicrobial substances, which are mostly derived from plants include terpenoids, essential oils, alkaloids, lectins, polypeptides, and polyacetylenes [7]. These compounds display antioxidant as well as antibacterial effects. It would be advantageous for both medical industry personnel and the public; if recyclable, eco-friendly, long-lasting antimicrobial fabrics that are effective against germs are developed.
The antibacterial property of P. guajava and C. gigantea leaves extract on regenerated bamboo fabric has not been studied in detail or reported in scientific literature. Therefore, limited information is available on the potential effects of Psidium guajava and Calotropis gigantea leaves extract on regenerated bamboo fabric.

However, it is known that P. guajava and C. gigantea leaf possess antimicrobial properties due to the presence of bioactive compounds such as flavonoids, phenolics, and tannins. These compounds have been reported to exhibit antibacterial activity against various bacteria, including Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Salmonella species.

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The antibacterial action of Psidium guajava and Calotropis gigantea leaf extracts on bamboo fabric was highlighted in the current investigation [8].

2. Materials and Methods

2.1. Fabrics and Study area

This study was carried out at Shri Vaishnav Vidyapeeth Vishwavidyalaya Indore, India. For the application of active compounds two varieties of fabrics regenerated bamboo fabrics in the bleached state were used. The test fabrics were sourced online, and the construction particulates are calculated.

2.2. Extraction of active compound

Fresh leaves of Psidium guajava leaves were collected from Burhanpur, M.P, India & Calotropis gigantea leaves were collected from Sendhwa. The leaves were washed under running tap water and dust was removed from the leaves. The leaves were dried at room temperature for 15 days, after that the dried leaves are grounded into fine powder in a mixer grinder (Philips mixer grinder and HL7701) [9] and the active compound was extracted by the maceration method in methanol (8). The active compound in powder form was taken from beaker and the extracts were collected in plastic bottle and stored at 4 °C temperature and was utilized for the finishing of fabrics.

2.3. Test Organisms

In this investigation, two types of pathogens were used as test organisms. Table 1 had a list of the organism's name, culture type, and collection source. Working cultures were kept at 4°C and kept on Nutrient Agar slants. The cultures of the Nutrient Agar slants were occasionally transplanted onto new Nutrient Agar slants.

Table 1 - Test Organisms

Organisms	No. of type culture	Source
Staphylococcus aureus	2079	National Chemical Laboratory, Pune
Escherichia coli	2065	NCL, Pune

2.4. Preparation of Perti dish

Media The antibacterial activity of P. guajava and C. gigantea on bamboo cloth was evaluated using two different types of media.

2.4.1. Nutrient Agar

(NA) used as the foundational medium. Susceptibility testing using nutrient agar is generally reliable. It was made with dehydrated Nutrient agar.

2.4.2. Nutrient Broth

(NB) For the inocula production, nutrient broth was made. All the parts of the Nutrient Agar were present in the nutritional broth, but not the agar.

2.4.3. Preparation of Nutrient Agar

In accordance with the manufacturer's instructions, nutrient agar was made from a commercially available dehydrated foundation. It was allowed to cool at room temperature right after autoclaving. In order to achieve a uniform depth of around 4 mm, the freshly prepared and cooled medium was poured into a sterile glass flat-bottomed Petri plate on a level, horizontal surface. After allowing the agar medium to settle to room temperature, the plate was either utilised right away or kept in an incubator (37°C). A sterile cotton swab was dipped into the suspension after each plate had been infected with the test bacterium, which had previously been adjusted to the 0.5 McFarland standard solution [10].

2.4.4. Preparation of Inocula

From a cryogenic vial, one loopful of the inoculum of each test organism was transferred into 9 ml of sterile Nutrient Broth (NB), where it was cultured for 24 hours at 37°C. The Nutrient Agar plate was then streaked with one loop of the NB culture, which was then cultured there for 24 hours at 37°C. The test organisms' inocula was created by transferring 3 to 4 colonies from nutrient agar cultures into 9 ml of sterile NB, which was then incubated at 37°C for 12 to 18 hours to form colonies. After an overnight incubation, colonies were chosen and transferred to a glass tube containing sterile physiological saline and carefully vortexed. The turbidity of each bacterial suspension is then contrasted with that of the 0.5 McFarland standard solution (which has approximately 1.5 108 CFU/mL) [10].

2.5. Preparation of Standard Fabric Sample

After washing of bamboo fabric, pre-mordanting has been done by using harad (5% own weight of fabric) at 50°C temperature, M: L (material to liqueur) =1:10 for 1 hour in laboratory water bath. Harad treated sample is used as standard sample [11].

2.6. Application of bioactive agent on test fabrics

Natural extracts of P. guajava and C. gigante were applied on the bamboo fabric samples; by using different concentrations (100µg, 50 µg, 25 µg, 12.5 µg /mg of fabric weight), which has been pretreated with Harad as a cross-linking agent, using Spray-dry-cure process. Fabric samples were prepared in the laboratory water bath at temperature 50± 2°C.

2.7 Evaluation of antimicrobial activity by the quantitative method

By using callipers to measure the zones of inhibition in millimetres close to the agar surface, antibacterial activity was measured, and the results were reported. The moment at which growth was completely stopped was considered to be the end point. In this experiment, the assay was carried out three times on each sample. Each sample performed testing for fabric weights of 100g, 50g, 25g, and 12.5g/mg. The untreated and the treated fabric samples were used for

testing, and antimicrobial efficiency was determined in terms as percentage inhibition of antibacterial zone (PIAG) [12, 13].

PIAG (%) = (Area of sample – Area of control)/ Area of control x 100

2.8 Statistical analysis

The inhibition zones were calculated as means ± S. D. (n=3). The significance among different data was evaluated by analysis of variance (ANOVA) using Microsoft Excel program. Significant differences in the data were established by least significant difference at the 5% level of significance.

3. Result and Discussion

The disc (treated fabric sample) diffusion method was used in the current investigation to test P. guajava and C. gigantea for antibacterial activity against S. aurus and E. Coli bacteria [14]. By evaluating the existence or absence of the inhibitory zone at various concentrations, the results were evaluated.

This conclusion is logical given that the antibacterial activity of leaf extract is influenced by a number of variables, including: a) various species, b) composition and concentration, c) microbial species and its occurrence level, d) processing conditions and storage [15-16]. It should be mentioned that the concentration of the extracts from P. guajava and C. gigantea affected their antibacterial activity [17].

3.1. Fabric specification

Quality particulars of fabric are given in table 2.

Table 2 - Fabric Specification

Bamboo Fabric	Plain weave
EPI	108
PPI	90
Warp Count and weft Count	40's Ne and 40's Ne

3.2. Percentage Extraction of leaves in Methanol

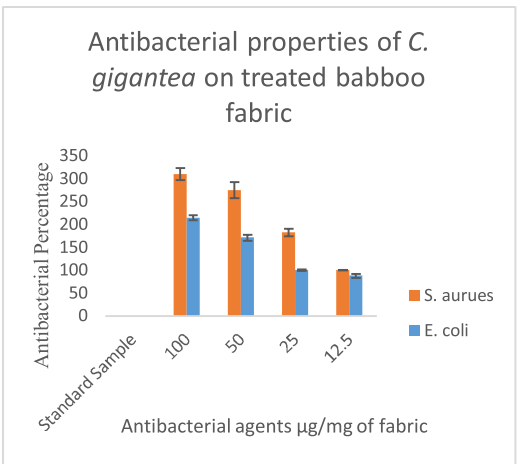
Crude or bioactive agents of C. gigantea and P. guajava leaves in methanol gives maximum extract for P. guajava leaves as compared to C. gigantea. It shows that maximum phytochemicals were extracted for P. guajava leaves. (Table.3)

Table 3 - Percentage Extraction of leaves in Methanol

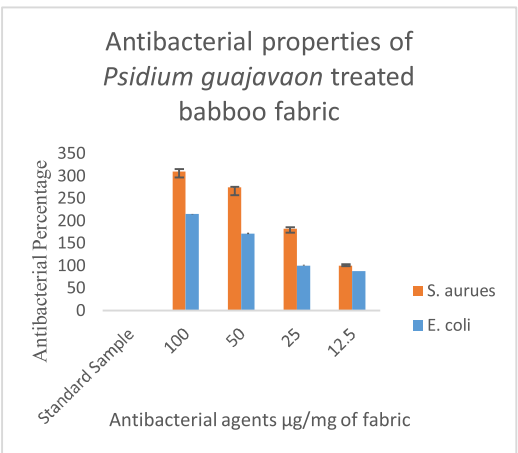
S. No.	AntibacterialAgents (5gm)	Methanol(100ml) as extraction medium
1	*Calotropis gigantea*	6.5%
2	*Psidium guajava*	8.9%

3.3. Evaluation of antimicrobial activity by disc (fabric) diffusion test (quantitative) [18, 19] by Antibacterial assay and ANOVA

The antimicrobial activity of the test fabrics treated with plant extracts was studied by the disc diffusion method. The level of antibacterial activity of fabrics treated with Calotropis gigantea and Psidium guajava plant leaves extracts was assessed by examining the extent of bacterial growth in the contact zone between the agar and the specimen and the width of the inhibition zone around the specimen. All the treated fabric samples showed significant inhibitory activity. It is observed that the zone of inhibition for the samples treated with C. gigantea leaf extract showed optimum antibacterial effect at 12.5 µg/mg of fabric sample while P. guajava leaf extract showed good results at 50 µg/mg of fabric sample as shown in graph 1 and 2. Table number 3 shows - Statistical Analysis of the effect of concentration of C. gigantea and P. guajava on antibacterial property (Linear Regression and ANOVA). This shows that the effect of concentration of C. gigantea on S. aureus and E. coli is 95% significant because p-value is lower than 0.05 while for P. guajava; null hypothesis was rejected as p value is less than 0.05 for S. aureus but there is no significant difference of concentration on antibacterial effect against E. coli.



Graph 1 - Antibacterial properties of C. gigantean on treated Bamboo Fabric



Graph 2 - Antibacterial properties of P. guajavaon on treated Bamboo Fabric

Table 3 - Effect of concentration of Calotropis gigantea and P. guajavaon on antibacterial property (Linear Regression and ANOVA)

	SS	df	F- Value	p-value	R Square	F crit
Effect of concentration of *Calotropis gigantea* on S. *aureus*	57686.72	1	10.98	0.016122	0.8106	5.98
Effect of concentration of *Calotropis gigantea* on E. *coli*	18608.42	1	7.28	0.0356054	0.933	5.98
Effect of concentration of *Psidium guajava* on S. *aureus*	4950.12	1	2.749	0.0148	0.995	5.98
Effect of concentration of *Psidium guajava* on E. *coli*	4950.125	1	2.74	0.148351	0.883	5.987378

4. Conclusion

Even though gram-negative bacteria were less sensitive to the antimicrobial property of guava leaves, it can be inferred from this experiment that Aakada leaves had stronger antimicrobial (antibacterial and antifungal) properties than Guava leaves extract. Considering their antimicrobial properties, polyphenolic chemicals may be the most likely source of the antifungal and antibacterial effects of guava and Aakada leaf extract.According to the research, both leaf extracts offer good anti-microbial properties for bamboo fabric. Therefore, using an herbal extract as an antibacterial treatment for textiles is a novel approach with a wide range of applications and commercial potential. The extract exhibited inhibition of bacterial growth for gram positive microbes S. aureus and gram-negative microbes E. coli. Bamboo fabric treated with Calotropis gigantea at 12.5 µg/mg of fabric weight showed 99.5 % antibacterial effect against S. aureus & for E. coli is 87.6% while Psidium guajava leaves extract showed 99.16 % antibacterial effect for S. aureus & 67.66% for E. coli for 50 µg/mg of fabric. These findings suggest that P. guajava and C. gigantea leaves extract has the potential to enhance antimicrobial properties of bamboo fabric, making it a promising outcome for antimicrobial textile applications. Hence, these leaves extract may be successfully employed in making antibacterial bandage fabric.

According to current research, the leaves of P. guajava and C. gigantea have the potential to be an excellent choice in the stalk for a natural antibacterial agent against topical wounds caused by E. coli and S. aureus.

5. Conflict of interest

Author declares there is no conflict of interest in publishing the article.

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Journal of the TEXTILE Association

Design of Innovative Product by Handcrafting of Waste Silk Cocoons

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Abstract

Silk is known as the "Queen" of textile fibers, and has been used since ancient times due to its unique properties such as draping, shimmering, and vivid painting. Since it is derived from silk cocoons produced by silkworms grown using safe environmental practices, which generally exclude the use of pesticides and only use minute amounts of compost fertilizers, it is regarded as a natural ecological fiber. This aspect is further supported by the chemical and physical characteristics of the material, such as its neutral pH scale, flexibility, lack of electrical conductivity, and high absorption capacity that makes it comfortable to wear. Individuals utilize silk made by the domesticated silkworm, Bombyx mori. The lepidopterous insect that produces silkworms is a member of the Lepidoptera order of insects, which also includes moths and butterflies. Good and healthy cocoons are used for extraction of silk but defective and pierced cocoons cannot be reeled to produce raw silk. Those waste cocoons were dyed and handcrafted to produce cocoon flowers, cocoon flower bouquets, cocoon flower garlands, and cocoon home decorative products.

Keywords: *Cocoon, Decorative, Ecological, Lepidoptera, Silkworms*

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1. Introduction

Individuals use silk from the tamed silkworm, Bombyx mori. The silkworm is a caterpillar of a lepidopterous insect in the order Lepidoptera, which includes moths and butterflies. Lepidoptera are holometabolous bugs, which means they undergo complete transformation over the course of their life. Silkworm moths, like butterflies, begin their lives as an egg that hatches into a developing, caring caterpillar. When a silkworm has consumed enough. It constructs a cocoon out of silk filaments. Within that cover, it changes into a pupa. After several days, a fully grown silkworm moth emerges from a spit-absorbed gap at the lower part of the cocoon. Dissecting a silkworm cocoon before the adult emerges reveals varied insights regarding the development of a silkworm into an adult moth, which is usually difficult to inspect through the walls of a cocoon once it has matured. During this, scientists dissect a cocoon and 'degum' it to reveal the macromolecule protein known as fibroin, which scientists use to build new materials. A silkworm builds its cocoon from the outside in, beginning with a platform on which it can rest while weaving, eventually tying the cocoon to surrounding plants. As the silkworm works its way into the cocoon's center point, the silk utilized to construct it thickens but becomes progressively narrow. The silkworm caterpillar is completely sheathed within after building its cocoon. There, it will gradually stop moving and shed its skin-like caterpillar exoskeleton to emerge as a pupa, the intermediate stage between the caterpillar and the adult moth. The exoskeleton, known as exuviae is left in the cocoon's lower part [1] .

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Silk is "the Queen" of textile fibers, being utilized from the old days owing to its special characteristics, draping, shining and bright painting. It's viewed as a natural ecological fiber since it's made of silk cocoons achieved in silkworm growing using harmless environmentally friendly technologies, which incorporates tiny quantities of compost fertilizers and primarily no pesticides[2] . This side is likewise supported by its chemical and physical qualities such as: neutral pH scale, elasticity, lack of electricity, high absorption capability that makes it comfy to wear.

Silk materials and clothes have an expensive look, lovely touch, novel shining and high security for human body movements to be needed and worn both by men and ladies [2]. Natural silk conjointly utilized in gadgets, physics and for clinical functions. Their fineness and obstruction create traditional silk fibers to be effectively used for manufacturing an enormous assortment of fabrics and extravagant clothes, however additionally bands and embroideries and different valuable things [2]. Therefore, silk worm rearing has been still an important financial branch, being practiced in around 40 nations.

Silk is a novel fiber. It has a characteristic reflexive look and has had an elegant history spreading over thousands of years. As of late, "bio-based polymers" have drawn in important thought since they will be used to foster carbon unbiased materials and bearable materials[3,4,5] . Since silk may be a bio-based compound, the silk business is going to be a good model for the recent chemo-organic cycle. Right now, the Japanese silk business is in decay [5] and is compromised by elimination. At that time, the inquiry that emerges is that the means of silk culture may be safeguarded. To ensure the safeguarding of the silk culture, two things ought to be urgently done: eco-accommodating silk merchandise with

additional value and a skillful silk creation framework need to be created.

Cocoon may be a quite exceptional and important biopolymer composite in nature with extraordinary microstructure and environmental capacities. It's been incontestable that cocoon, aside from its undeniable textile application, present uses of great interests in the field of biomedicine and tissue designing. The spectacular art of crafting silk waste is one amongst the fascinating utilities of silk that develop human skills besides generating self-employment and extra revenue.

2. Materials and Methods

2.1 Required materials for cocoon crafting

The primary raw material (cut/pierced cocoons) was obtained from Central Silk Technological Research Institute, Central Silk Board, Bangalore. These cocoons were ripped open from one end, and the cap piece, as well as the cocoon body, were used to manufacture several handcraft products. Depending on the type of cocoon handicraft to be designed, the following equipment are required: scissors, zig-zag scissors, blade, cotton thread, cardboard, drawing sheets, needles, fabric glue, craft paper, glaze paper, velvet paper, adhesive tape, colour tape, stapler, plastic ornamental material, soft binding wire, beads, chemical dyes, and dyeing vessel, as well as a heater for cocoon dyeing, are all required. Instead of using heaters, firewood used for domestic purposes that are used to dye cocoons. Fabric paint and water colour was used to make cocoon crafts.

2.2 Extraction of silk

The Silkworm Life Cycle begins when the female silk moth lays eggs. The larvae or caterpillar enters the picture as soon as the eggs hatch. After eating mulberry leaves, the silkworms pupate. The silkworm spins a net around itself to keep itself together during the pupa stage. Many caterpillars form a protective layer around the pupa, which is known as a cocoon. The silk moth's cocoon, which is used to make the yarn. Silk processing refers to the extraction of silk from the cocoon. By exposing the silk to sunlight, it is separated from the cocoon. When silk is extracted, it is reeled, which is the process of unwinding silk from the cocoon. Following the reeling process, the silk thread is bleached before being spun into silk thread. The silk production process is depicted in the flowchart below figure 1. China, India, Thailand, Korea, Brazil, France, Italy, and Japan are the top silk producers. In China, the silk industry employs approximately one million people. The Silk sector employs approximately 7.9 billion people in India. China is the world's largest producer of silk, with India coming in second with up to 2000 metric tonnes produced per year[6,7] .

Silk cocoons are made from a naturally occurring polymer protein material. A silk cocoon's primary component is fibroin, and the outside is covered by four layers of sericin with varying molecular weights. Sericin makes up 25 to 30% of silk cocoons. Degumming is usually required in the textile industry to obtain silk from cocoons. The removal of sericin improves the sheen, softness, smoothness, whiteness, and dyeability of silk cocoon fibres. As a result, the extracted sericin solution is frequently an unused by-product of the textile industry. Every year, approximately 50,000 tonnes of sericin are discarded globally, putting a strain on the environment. Sericin contains 18 amino acids, the most important of which are serine, histidine, glycine, threonine, tyrosine, and aspartic acid, and glutamic acid. Furthermore, sericin is a promising biological material due to its antioxidant capacity, moisturising capacity, corrosion resistance, antibacterial activity, and UV radiation protection[8].

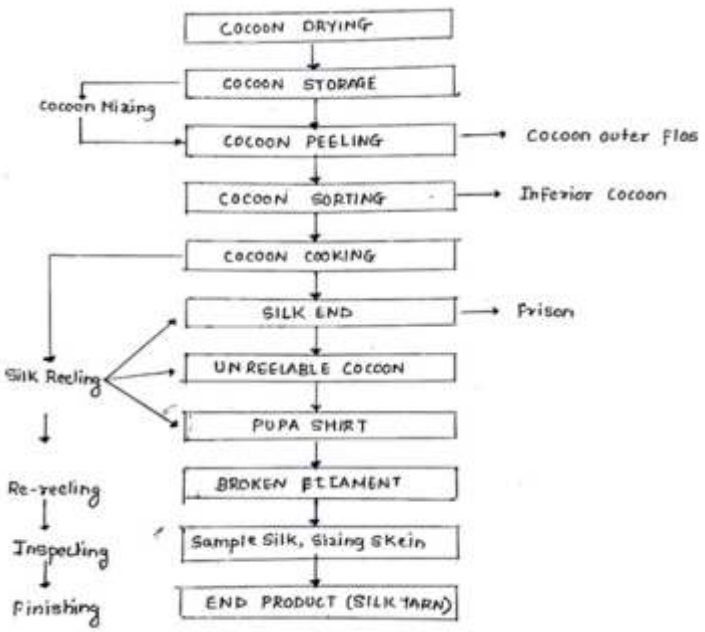

Figure 1: Extraction flow process

2.3 Fiber properties

A couple of fibroin brins with a sericin coating are silk fibres that are transformed into cocoons. It serves as the nonwoven composite network stage for the cocooning and links the fibres together in a damp or clammy covering. To examine if intrinsic fibre brin characteristics may have a demonstrably significant role in cocoon qualities, reference non-degummed fibres with perfect sericin coatings were disentangled from cocoons. The average of the helpless relationship between the parameters of the fibre and the cocoon, as shown in Fig. 2. Fig 2 shows that the fiber strength has little relationship with cocoon strength, which is the average of the connection among fiber and cocoon properties. All the fibers share a comparable starting modulus and a yield at 2 – 4% strain. Significantly, most fibers have a resist break around 16%. Starting examination of the information may give the impression of high fluctuation between silk types, yet a similar plot for a solitary silk type, a S. pyri fiber, shows practically identical example variability. Various layers in cocoons contrast significantly, and

surprisingly spatially close examples can be altogether different because of elements, for example, twisting of the fibers in the movement the worm makes while turning the cocoon. Different perceptions on B. mori report diverse malleable properties in various layers of the cocoons. As a result of factors like the twisting of the strands caused by the worm rotating the cocoon, for example, various layers in cocoons contrast greatly, and unexpectedly near specimens might be completely different.

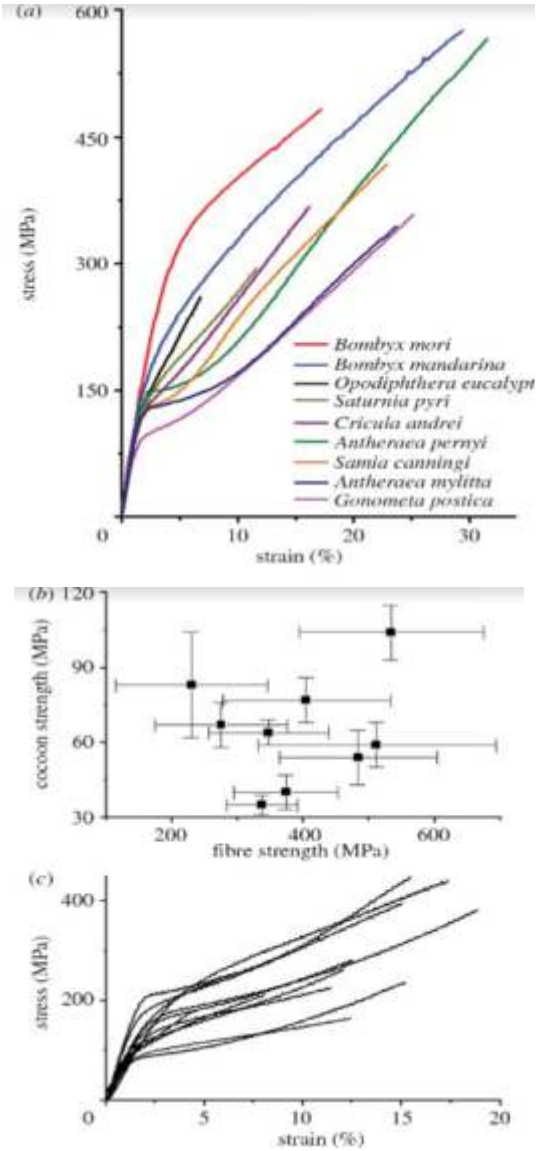

Figure 2: Fibre properties of cocoon

It has been successfully demonstrated that the degumming interaction can influence the mechanical conduct of fibres degummed with various specialists and so ease us from the spirit strating the mechanical conduct of fibres. The construction and characteristics of the fibres themselves can be severely harmed by the harsh degumming technique required for extremely strong coons. Most fundamentally, non-degummed fibres would have larger cross-sectional areas than degummed due to the more fragile sericin layer, resulting in poorer strength and modulus values when compared.

2.4 Dyeing of cocoons

Typically, silk is dyed at the fabric or yarn stage. Various investigations into the colour characteristics of silk fabric and yarn have been conducted. As far as anyone is concerned, no creative and rational research on silk dyeing has been done during the silkworm cocoon stage. The objects aesthetic appeal is increased by the many hues that provide attraction and appeal to them. A crucial component of cocoon handicraft planning is dyeing or colouring, which gives the cocoons a shaded appearance. It should ideally be tinted with natural pigments to highlight the craftsman's originality and give value to it. The silk yarn or cloth can also be coloured using artificial colours. Only soft water can be used to colour the cocoons because hard water consumes more colour and may cause uneven dyeing. The water is made to bubble, and the appropriate amount of colour powder is added. Approximately, 1 kg cocoon requires about 100 gm of colour. First, combine it with 100 ml of hot water. It is constantly mixed to avoid the formation of clumps and to filter the colour solution. The dye solution is then added to the boiling water and thoroughly mixed to ensure uniform colour blending. At that point, the clean, deflossed, and double-discarded cocoon is dipped in this solution. It is repeatedly mixed until the colour retention of the dipped cocoons is uniform. Cocoons should be dipped up to 50°C; any higher temperature will affect its sericin content, giving these cocoons a distorted appearance. To avoid de-coloration, remove the coloured cocoons from the solution and allow them to dry in a single layer under shade. Figure 3 shows the dyed cocoons. These coloured cocoons are ready to be transformed into desired items [8].

Figure 3: Dyed cocoons

2.5 Cocoon crafting

The Indian economy places a lot of emphasis on craftsmanship. One of the intriguing applications of results that will extend human capacity for autonomous labour and

revenue generation is the specialty of cocoon production. In post-cocoon regions, the value decision is based on low risk and high salary value added by products ranging from 10% to 25% of total returns. The leftover silk cocoons are used to make a variety of items, including laurels, flower vases, wreaths, pen stands, dolls, tapestries, divider plates, timepieces, flower bouquets, and greeting cards. A few research institutes in Japan have developed silk paper in a variety of tones for use in constructing blossoms and light stands. To design objects made of plastic, steel, imitation adornments and textures, and metal, silk calfskin and a paint containing silk powder are employed. hand-woven products, hand-tied cocoons, and scarves and fabrics that have been hand-printed. Japan received deliveries of half-breed silk, net raw silk, silk town, and silk wave for use in creating undergarments, coats, sweaters, floor coverings, and other products. One of the unique characteristics of the handiworks is that they are made in different places and are therefore unique in terms of their craftsmanship, style, and colour. On exceptional occasions, officials and guests are presented with bouquets and garlands of rose flowers. Regular flowers only retain their freshness for a relatively brief period of time and ultimately dries. Additionally, it implies that the money used to purchase these distinctive but transient new blooms was wasted. Unexpectedly, if we give the guests cocoon-made flower wreaths or bundles as a token of our appreciation, they will take it home and keep it for a long time as a decorative accent. To support aesthetic allure and desire, Cocoon ensured that objects maintained their brilliance for a considerable amount of time. The use of cocoon-shaped goods is gaining ground and appeal as a craftsmanship movement [9].

The cocoon products were consistent size and shape. The soiled and stained cocoons were dismissed. The separated cocoons were going to be deflossed eventually. These deflossed cocoons were coloured and given legitimacy utilising cutting edges, scissors, etc. In accordance with the item setup. The chopped cocoon's crown portion was frequently employed in the creation of tiny beaded garlands, cards, and opulent items[9] .

3. Results and Discussion

Petal-sized pieces of the coloured cocoons were cut out. By employing 3 to 4 cocoons, each cocoon was divided into 3 to 4 petals. It was shaped more compactly. By using glue petals were fixed. When the flower has dried, poke a pointy needle into the centre of it to attach a decorative wire, then bundle the lower portion of the flower which can serve as the flower's tail at the top. A green cocoon was chopped into the shape of leaves. Around the blossoms were arranged these leaves. In its place, a fake plastic leaf was frequently utilised. The flowers formed from cocoons are depicted in figure 4[7]

F*igure 4: cocoon flower*

3.1 Cocoon flower bouquet

Cocoon flower bouquets come in two varieties: single flower bouquets and bundle bouquets. A single bouquet was created by attaching two or three flowers and a leaf to a branch-shaped green plastic wire. It was wrapped in a funnel-shaped clear transparent sheet with cello tape and lined with a coating paper. It would appear as if it were a brand-new rose bouquet. A bundle bouquet was created by combining 25 to 50 packs of various shades and colours of cocoon flowers. The number of flower cocoons required is determined by the size and arrangement of the bouquet to be created as shown in the figure 5 [7].

Figure 5: Cocoon flower bouquet

3.2 Cocoon garland

The cocoons were cut with a scissor into floral and leaf shapes. Colored cocoons were used instead. Some gold-colored beads were added at the end of the cocoon flowers, trailed by a flower and beads again on the opposite hand with the help of a needle/string framing a state of garland. The number of cocoons needed to fill the wreath depends on its length. This is a rich-looking garland that can be planned in three lines with a central cocoon pendulum design. The

garland with a weighty bouncy look required approximately 500 cocoons. Cocoon flower garlands are more elegant and last much longer. About 1 kg cut/pierced cocoons were used to make approximately 6 large garlands. Beaded white and coloured caps may enhance its visual appeal. This type of garland was light in weight, delicate with a nice appearance, and easy to convey a gift. The cocoon garland is depicted in Figure 6 [7] .

Figure 6: Cocoon garland

3.3 Interior decoration products

Home decor items like birds, Lord Ganesha images, wall hangings, little mulberry or other trees, famous buildings like the Taj Mahal and the Snowman, or other items of stylish, trendy value that may demonstrate the creative talent of workmanship, were made by cocoons. The cocoons were divided into extremely small pieces of various designs, and these pieces were assembled to form certain forms that were then adhered on special paper or velvet. After being given an inventive touch by finishing, expensive glass was printed, presented, and offered for sale. These items are quite attractive and draw both customers and dignitaries [10] . The things made in a cocoon are shown in Figure 7.

Figure 7: Cocoon home decors

4. Conclusion

The silk industry updates the concept to make sericulture a financially viable proposition, enabling it to compete successfully against other cash crops. Through natively accessible handling processes, usable results can be improved, resulting in increased compensation and personal financial gain. Craftsmanship skills are used to create ornaments such as garlands, flower jars, wreaths, pen stands, dolls, goldsmiths, tapestries, clocks, flower bouquets, and greeting cards. The silk-based material is used to create blooms, table lights, and to highlight textures, plastics, and steel. The promotion of the idea of considerable value growth through appropriate training, cross-disciplinary projects, and global advertising should be the focus of R&D organisations and sericulture offices in order to achieve a successful outcome employing the handcrafting concept of silk cut cocoons. recognising the length of value growth. A crucial component of the silk business is the silk cocoon. The sericin found in silk cocoons, however, is typically discarded. Sericin has a variety of useful components, and manufacturers are becoming more and more interested in using it in skin care products.

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Journal of the TEXTILE Association

FASHION

Fast Fashion– A Destructive Loop of Overconsumption

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Abstract

Textiles play a significant role in our daily life. In addition to serving the basic requirements, textiles are increasingly becoming a fashion statement as they spread across society. The fashion industry is one of the biggest polluters in terms of waste generation, resource utilization, and consumption of water. Hence, there is a need for a fundamental fashion business model, that includes sustainable practices throughout the supply chain and an increasing product life cycle. It also deals with the conscious choices made by the consumer while purchasing. There are two competing ways to look at the fashion industry: slow and fast. Slow fashion emphasizes high-quality, timeless designs and ecological and ethical business practices, whereas fast fashion is characterized by cheap, fashionable, and disposable apparel developed fast and marketed at low prices. In the current era, overexposure to the newest fashion trends has resulted in an inclination towards fast fashion, which is connected to several environmental issues, including resource consumption, greenhouse gas emissions, land usage, landfills, soil degradation and deforestation, excessive water consumption, air pollution, microfibre pollution, packaging pollution, etc. The inclination towards fast fashion is mainly due to the use of social media and digital marketing. This paper provides an analysis of the relationship between fast fashion and its environmental issues.

Keywords: *Consumer, Environment, Fashion, Greenwashing, Micro-fibre, Pollution*

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1. Introduction

The role of textiles in our daily lives is enormous. As textiles become more ubiquitous, they are not only fulfilling the basic needs of mankind but are also becoming a fashion statement. Fashion can be defined as the expression of aesthetic values at a specific time and place. It reflects a particular period's social, economic, and artistic expressions through clothing, footwear, accessories, makeup, and lifestyle. There is an interconnection between fashion and style. To become a fashion, the audience must widely accept a style. Fashion is a dynamic concept characterized by change occurring in a general direction. These changes are termed trends. In the current era, a tendency towards fast fashion has arisen due to excessive exposure to the latest fashion trends.

Human activities have a broad and varied impact on the environment. There are several ways in which the human race contributes to the degradation of the environment; one of these is through the fast fashion industry. Fashion is one of the world's largest, most globalized, and most important industries. Fast fashion is typically a business model that deals with trendy, easily accessible clothing intended to endure only a few uses before being discarded in a landfill. A fast fashion product leaves a pollution footprint at every stage of its life cycle, from fiber production to post-consumer disposal. Figure 1 depicts different fibers used in textiles and fashion. This study thoroughly analyses the relationship between fashion and its environmental effects.

Researchers have discussed and reported the environmental impacts concerning the textile and fashion value chain [1]. Rukhaya et al. analyzed and reported sustainable approaches and alternatives to fast fashion [2]. Researchers investigated and discussed different dimensions of slow fashion and its versatility [3]. Researchers hypothesized that clothing libraries could promote a longer service life for clothes, reducing the fast production of garments, and also analyzed and reviewed the environmental impact of the textile supply chain [4]. Roy Choudhury discussed in his paper the importance of a textile product's Life Cycle Assessment (LCA) to examine the textile industry's environmental impacts [5]. Petroody et al. reported that most microplastics found in water treatment plants were microfibers, of which polyester microfibers were the most abundant, followed by polyamide and acrylic microfibers [6]. Researchers examine the relationships between positive or negative social media communications, fashion-conscious consumers, and purchase intentions. Consumer purchasing behaviour was found to be strongly influenced by social media [7].

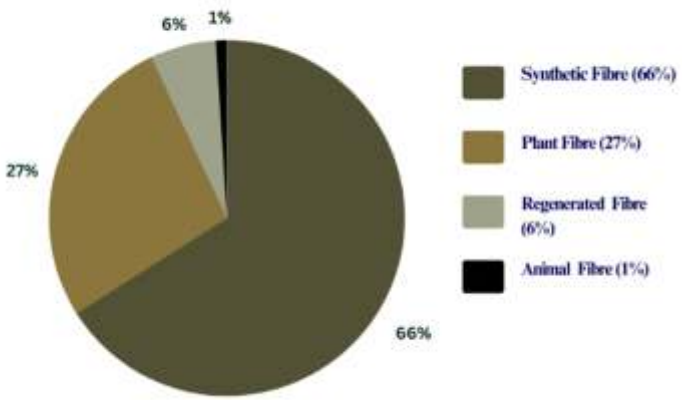

Figure 1: The fiber used in textile and fashion

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2. Fast and Slow Fashion

The term 'fast fashion' refers to a method for manufacturing and marketing fashion garments that focuses on making the latest trends available to consumers quickly and at an affordable price. The globalization of fashion trends has facilitated the rapid growth of this industry. Typically, fast fashion collection ideas are derived from the runway shows of luxurious brands. This business strategy allows mainstream consumers to purchase the latest fashions in an affordable way [2].

Textile manufacturing has increased dramatically due to global population expansion and fast fashion. Fashion is one of the most polluting industries, accounting for 8% of total carbon emissions and 20% of world wastewater [8]. The fashion sector generates more carbon emissions than international aircraft and shipping, consuming around 93 billion cubic meters of water annually. Figure 2 shows the impact on the environment of the textile and apparel industry.

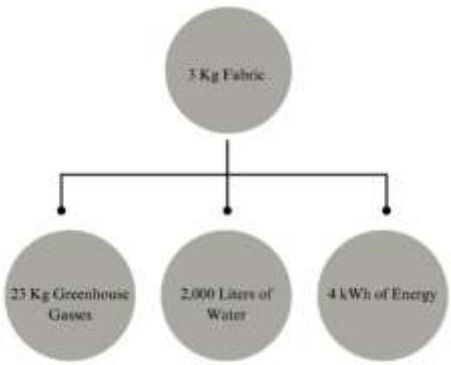

Figure 2: Environmental impact of the textile and apparel industry

The slow fashion movement promotes a more ethical and environmentally friendly method of clothing manufacture and consumption. It encourages people to invest in well-made, long-lasting clothing by emphasizing quality above quantity. Slow fashion prioritizes waste and environmental impact reduction and the promotion of ethical work practices in contrast to the fast fashion sector, which is characterized by quick style changes and inexpensive labour and materials. This could include using production methods that use the least amount of water, energy, and sustainable materials, such as organic cotton or recycled textiles. In addition, slow fashion strongly emphasizes supply chain transparency, guaranteeing that employees receive fair compensation and work in safe and healthy environments [9].

Although fast fashion allows consumers to buy more clothes for less money, it also impacts the environment. It creates possible occupational and environmental hazards at every stage of the clothing life cycle. Numerous environmental problems are linked to fast fashion, including resource consumption, greenhouse gas emissions, land use, landfills, soil degradation and deforestation, excessive water consumption, air pollution, microfiber pollution, packaging pollution, etc. [2]. The fashion industry is estimated to use large amounts of water, averaging 200 metric tonnes while producing one tonne of textile [1]. The garment sector affects local water resources by generating wastewater, which goes beyond aggravating water scarcity. Untreated wastewater that reaches the local groundwater might harm the entire ecosystem since some of the chemicals used in production are poisonous. The most greenhouse gases are produced per unit of material by textiles. Over 15,000 different chemicals are used by the textile industry during manufacturing, starting with the synthesis of fibers [1]. According to estimates, cotton crops consume 6% of global pesticide production, including 16% of insecticides, 4% of herbicides, growth regulators, and defoliants, and 1% of fungicides. Agrochemical use can contribute to nausea, diarrhoea, cancers, and respiratory diseases. At the same time, acute pesticide poisoning is responsible for nearly 1,000 deaths a day and affects neurological and reproductive problems, such as infertility, miscarriage, and birth defects [1]. Fast fashion production and consumption have dramatically increased, which has led to a rise in textile waste. Pre-consumer waste in the fashion industry, also known as production waste, is created during the production of textiles and apparel. It comprises waste from manufacturing fiber, yarn, and fabric [1]. In the past few years, significant focus has been placed on a pre-consumer waste category known as 'deadstock'. It describes products or inventories that have not been sold and are no longer required by the manufacturer, distributor, or retailer. Various factors can lead to deadstock, including overproduction, cancellations, or changes in design and trend.

3. Fiber to Fashion

The textile industry consists of natural fibers (such as wool, silk, cotton, linen, hemp, etc.) and man-made fibers (subdivided into regenerated, synthetic, inorganic, etc.). The most common are synthetic fibers derived from petrochemicals, such as polyamide, polyester, and acrylic. Synthetic fibers are becoming the fashion industry's one of the miracle solutions. As a result of their affordability, durability, and ability to be manipulated, these fibers are popular with fast fashion companies [2]. Over the last two decades, the production of fibers for textile manufacturing has doubled, while the population has only risen by 25%. This significant boost in fiber production is evidence of the growing demand for textiles worldwide. It highlights the importance of the textile industry as a key player in the global economy [10].

3.1 Pollution through Polyester Value Chain

The traditional polyester garment value chain includes several sectors. These include textile manufacturers who produce polyester fabrics, apparel manufacturers who create the clothing, wholesalers who distribute the garments to retailers, and retailers who sell the clothing to consumers. Each industry is essential in bringing these polyester garments to market, ultimately providing consumers with diverse and fashionable clothing options.

The value chain starts in the oil sector since it obtains and refines crude oil to provide the fundamental elements that the chemical industry uses to make PET (Polyethylene Terephthalate) and other chemicals. The chemical industry supplies PET chips to the textile sector, where they are processed and extruded into fibers and yarns. Through professional knitting or weaving processes, these yarns are subsequently utilized to produce high-quality textiles. Incorporating dyes and chemicals is essential to achieving specific qualities in fibers and textiles [10]. These processes need extensive energy, and improper waste handling in the supply chain may pollute the land and the water. Direct release of chemical or dye effluent into adjacent bodies of water causes environmental hazards. Microfibres are discharged into the atmosphere while making textile articles from polyester fiber and remain there as particulates in the air. Due to daily exposure to hazardous compounds, including microfibers, synthetic dyes, and petrochemicals, factory employees are at significant risk of developing health issues. Asthma, lung infections, and allergies are more common due to this exposure, which can happen by inhalation or skin contact. The dyeing and finishing of textile products are responsible for around 20% of the world's water contamination [10]. The chemicals used to produce textiles include detergents, flame retardants, stain repellents, softeners, careers, etc. The residues of these substances, often not biodegradable, may be released into the environment, where they are likely to propagate and possibly reach the food chain [10]. Avoiding hazardous chemicals during the finishing process will increase the sustainability of textiles and adhere to circular design concepts by allowing garments to be recycled without contaminating recycling systems.

The various stages of the textile value chain are commonly executed in various countries or regions. For instance, oil is extracted in one location and transferred to another for refining and producing chemicals like PET since not all countries have oil reserves. The PET chips can be sent back to a different site to be transformed into fibers and yarns, then transported to a different place to be converted into fabrics. These are then delivered to many destinations so retail stores can purchase them. Global warming has been accelerated by the significant carbon footprint created by transporting raw materials, fibers and yarns, textiles, clothing, and all the chemicals required at each stage [10].

The term 'carbon footprint' refers to the total amount of greenhouse gases, particularly carbon dioxide, that one person, organization, action, event, or product emits throughout its lifespan. Carbon dioxide accounts for roughly 80% of industrialized emissions and is the primary root cause of global warming. The primary cause of carbon footprints is the combustion of fossil fuels such as coal, oil, and natural gas, which emit CO_2 into the atmosphere. Deforestation, industrial processes, agriculture, and transportation contribute to greenhouse gas emissions. The textile business emits considerable amounts of CO_2 during its entire lifecycle, including raw material production, manufacture, transportation, and waste disposal.

Environmental sustainability may be made possible by considering the whole life cycle of textiles, starting with the design and material procurement process. Regarding carbon emissions, the term 'carbon neutrality' describes a situation where there is no net release of carbon dioxide (CO2) emissions into the atmosphere. It is accomplished when a unit, such as an organization, community, or nation, balances the quantity of CO2 it emits and the amount of CO2 that is removed proportionately.

3.2 Microfibre Pollution

Since the discovery of microplastics (tiny particles ranging in size between 5 mm to microns), much effort has been made to research the issues. Like bigger plastic particles, microplastics are made of polymers such as polyethylene, polystyrene, etc. Various researchers have attempted several studies to determine the quantity of microplastic particles in a body of water. The outcome reveals that microplastics may be found almost everywhere, even in deep-sea trenches, and according to them, most microplastics found in water are microfibres [11]. Each year, the amount of microfibres released into the ocean varies from 2 million, with approximately 700,000 microfibres escaping through washing machines [12]. Microfibres can be released into the environment through synthetic fiber production, use, and disposal. These microfibres harm marine life because they are eaten by fish and other species in marine ecosystems [13].

3.3 Marine Impact of Fast Fashion

By discharging microfibres into the environment, fast fashion adversely affects marine life. During washing, polyester, nylon, and acrylic release microfibres that may harm marine life in waterbodies and oceans. Microfibres can impact marine life in several ways, some of which are listed below:

- Marine species, such as fish and shellfish, can consume microfibres after mistaking them for food. This can lead to digestive issues, starvation, and even death.
- During their journey from the sea to the land, microfibres can accumulate in the bodies of marine animals. This can lead to toxic effects as they reach higher levels of the food chain.
- In addition to destroying coral reefs, microfibres contribute to a decline in biodiversity and ecosystem loss.

4. The Psychology of Fast Fashion

Psychological factors play a significant role in fast fashion, which depends on a range of factors that drive consumer behaviour and contribute to the growth of this business model. The desire for novelty and trendiness among consumers drives fast fashion. Consumers frequently become attracted to it because it delivers a steady supply of

fresh trends and patterns, which can create a sense of excitement and expectation.

4.1 Role of Social Media and Advertisement in Fast Fashion

Increasing social media use and website advertising have heavily commercialized this fashion form. In several ways, social media has contributed significantly to the growing popularity of fast fashion [7]. For fast fashion businesses, social media networks like Instagram, Facebook, Twitter, and TikTok have made it easy for them to promote their exclusive products and instantly reach a large audience.

Fast fashion clothing is promoted and worn by influencers and celebrities who have large followers, which generates interest and buzz about the brand. People want to keep up with the newest trends and flaunt their fashion choices on social media, creating a culture of instant satisfaction. Additionally, social media gives fast fashion brands immediate feedback on their products. It allows them to reach a much wider audience with a few clicks, enabling them to sell their products worldwide [14].

The popularity of fashion hauls has increased in recent years due to the growth of social media and influencer marketing. A 'fashion haul' is a video or blog post on social media showing people their latest purchase from an apparel shop or online market. Usually, the content maker displays each item they bought, tries it on, and provides feedback on how well it fits and looks. Hence, many fashion hauls promote the most recent trends and guide viewers to frequently update their wardrobes, contributing to a society that embraces fast fashion.

The targeted advertisement also plays a vital role in the growth of fast fashion consumption. Using data and insights on users' behaviour, interests, demographics, and other factors, targeted advertising shows more relevance to selected consumers than showing identical advertisements to everyone. User data, including search queries, browsing histories, social media activity, and purchase histories, is gathered and analyzed for targeted advertising. Providing fashion buyers with more information about brands and product purchase decisions that influence them might cause excessive consumption of fashion garments.

5. Growth of E-Commerce

The term 'e-commerce' refers to the exchange of products and services through the Internet. Online shopping has drastically changed the clothing purchasing pattern due to its convenience and accessibility. E-commerce has complex environmental effects since it reduces emissions in some areas while increasing emissions in others. Shopping online provides consumers with an endless selection of products much more quickly and efficiently than possible in a physical store; also, with this shopping experience, consumers can learn more about their products by reading descriptions and reviews. One significant advantage of online shopping is the convenience of browsing from home or while traveling and making purchases at any time. Additionally, e-commerce has reduced production costs for fast fashion brands by reducing their dependence on physical stores. All these factors contribute to the growth of overconsumption of fast fashion products. For faster delivery, companies often divide orders and ship them separately instead of together, increasing packaging and transportation costs and carbon emissions. The packaging of products, including the shipping containers for online orders, accounts for 29.8% of waste in the United States, or 75 million tons. Many materials are not recyclable [15].

6. Sustainable Consumption of Textiles

Choosing more responsible and conscious choices when purchasing, using, and disposing of textiles and fashion garments is one way to ensure sustainable consumption. Investing in durable, long-lasting, sustainable garments can reduce the need to replace garments. Many natural, sustainable fabrics from natural fibers such as organic cotton, linen, hemp, and bamboo are available to consumers. These natural fabrics are eco-friendly to produce and use. A great way to reduce the demand for new clothing is by purchasing second-hand clothing or using clothing libraries.

Using the earth's resources more judiciously is a necessity without question. Significant environmental issues caused by the current business model include deforestation, loss of biodiversity, and an increase in carbon dioxide (CO2) emission and pollution. Several concepts for an environmentally friendly future emphasize reducing, recycling, and reusing to reduce the industry's environmental impact. The transition to a more sustainable fashion industry, for instance, could involve a business model where society switches from a take-make-dispose economy to a circular economy that aims to keep all resources or products in the system for as long as possible to reduce end-of-life textile waste [8].

It is possible to extend the useful life of a discarded garment by transferring it to a new owner via second-hand stores or charities when it is still wearable. The garments can also be diversified into something new and useful.

7. Consequences of Greenwashing

Greenwashing, or misleading claims about sustainability to boost a brand's reputation [10]. Even if their products or activities are not, brands may utilize greenwashing market strategies to give the impression that the products are eco-friendly or sustainable. Greenwashing may take many forms, including the vague or intangible use of phrases like 'eco-friendly' or 'sustainable' without any additional information on the environmental effect of the item or service. Even if a product has minimal or no link to the natural world, companies may employ deceptive visuals to suggest that it is environmentally friendly, such as images of wildlife or natural landscapes. Another common approach is to highlight the insignificant environmental aspects of a

product while ignoring or underestimating its more important environmental effects or to do so by utilizing false or unrelated certifications or labels to suggest that a product is environmentally friendly.

Both the environment and customers may suffer highly as a result of greenwashing. Companies may destroy consumer trust and make it more difficult for customers to make knowledgeable choices by misleading them about the environmental effects of their activities or products. Greenwashing also makes it more difficult for customers to differentiate between real environmental claims and marketing hype, which may harm the efforts of businesses dedicated to sustainability and environmental responsibility. Identification must be strictly governed to prevent this problem and maintain eco-labeling reliability. In addition, clothing retailers should support sustainability and incorporate educational content to reassure consumers that they are getting a good deal when purchasing items with an eco-label [10].

7.1 Global Regulatory Body

Understanding of safety requirements of textiles and apparel are essential to protect consumers and the environment from the harmful effect of restricted substances. Generally, a restricted substance must be absent from a finished product or present at a limited concentration. Some substances are restricted due to environmental concerns, while others are restricted due to health and safety concerns for workers or consumers. The Global Organic Textile Standard (GOTS) is a measure for promoting social accountability and ecologically responsible manufacturing practices worldwide. It includes all aspects of producing, modifying, manufacturing, packaging, labeling, exporting, importing, and distributing all-natural fibers. GOTS establishes strict environmental standards for the manufacture of textiles. Heavy metals, hazardous chemicals, and genetically modified organisms are all forbidden; any packaging made of PVC is prohibited. Along with encouraging trash reduction and recycling, it also enforces appropriate water and energy usage. As part of its supply chain, GOTS takes social factors into account. The International Labour Organisation conventions must be followed, particularly those that forbid child and forced labour. It guarantees a right to wage negotiation, secure working conditions, and appropriate wages. A product must be 67% recyclable or biodegradable to receive Cradle-to-Cradle (C2C) certification. REACH is the European Community Regulation on chemicals and their safe use. It refers to the Registration, Evaluation, Authorization, and Restriction of chemicals. REACH aims to improve the protection of human health and the environment through better and early identification of chemical substances. The OEKO-TEX is an independent third-party certifier that offers OEKO-TEX 100 for products and OEKO-TEX 1000 for production sites/factories. Textiles considered for this standard are classified into four categories: Product Class I: products for babies; Product Class II: products with direct contact with skin; Product Class III: Products without direct contact with skin and Product Class IV: decoration materials. The Global Recycled Standard (GRS) is a holistic certification for products with recycled content, whereas the Recycled Content Standard (RCS) applies to products that contain 5%–100% recycled material. Other examples of different certifications are SMART (Sustainable Materials Rating Technology), GreenGuard, Consumer Product Safety Act, Environmental Protection Agency, Eco-Mark Scheme of India, ISO 14000 Series, etc.

7.2 Government Policies

The environmentally harmful supply chain operations of the fashion industry are now coming under increased global scrutiny. However, the industry continues to expand despite widely publicized criticism over its limited consideration of social and environmental issues. It is estimated that the industry produces 8-10% of global CO2 emissions and is also a major consumer of water, responsible for ~20% of industrial water pollution, and contributes ~35% of oceanic primary microplastic pollution [16]. The environmental impact of the textile and apparel industry clearly explains that one kilogram of fabric uses 2,000 litres of water and 4 kilowatt hours of energy which generates 23 kilograms of GHG [17].

In India, the fashion industry is also subject to several environmental laws. The Water (Prevention and Control of Pollution) Act of 1974, the Air (Prevention and Control of Pollution) Act of 1981, and the Environment Protection Act of 1986 are the primary environmental legislation that applies to the industry. The Indian government has introduced different policies to mitigate the effects of fast fashion, through zero liquid discharge norms (ZLD), zero defect, and zero effect (ZED). Sustainable fashion is an approach that changes and promotes fashion products while also ensuring their fashion and ecological integrity. The government promotes a sustainable fashion policy and also tries to educate both producers and consumers while producing and purchasing products. Sustainability is a huge challenge in the fashion industry and textile waste can be used as raw material for those value-added products. Fashion industries generate 4% of the world's waste each year, and the majority of the clothes that are produced by fast fashion are inorganic and synthetic. So, they are unable to degrade properly and these chemicals in the fabrics pollute the environment. Textile waste is largely classified as pre- and post-consumer waste. The textile and clothing industry recycles 75% of the industry-generated pre-consumer textile waste, whereas, only 15% of post-consumer waste is recycled. Figure 3 describes the hierarchy of waste management. Waste hierarchy is a framework for waste management, which has become widely adopted in recent years. According to this framework, a hierarchy is established in the order of priority of the way by which waste needs to be handled or managed to achieve the minimum environmental impact. The hierarchy sets out six levels of waste management. In descending order of preference, these six levels are (i) prevention, (ii) minimization, (iii) reuse, (iv) recycling, (v) energy recovery, and (vi) disposal.

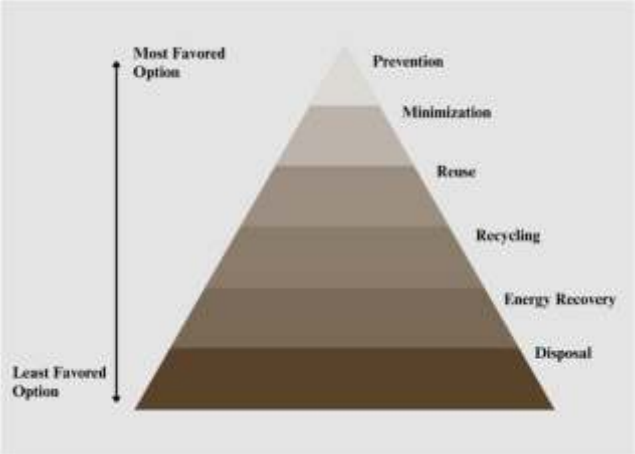

Figure 3: Hierarchy for waste management

8. After Life of Garments

Pollution is generated from disposing of clothing in landfills and combustion plants, but the loss of value is the most important issue regarding its effects on the environment. The value of the clothing is regenerated once the manufacturing of new clothes abandons it. This has a significantly larger environmental impact than just the disposal procedure. Therefore, improving sustainability at the end of life depends on increasing the reuse and recycling rates for unwanted clothing. Garments made of polyester accumulate in landfills due to conventional PET's inability to degrade, so they last for a long time, even if they are only used for a short time [10].

9. Conclusion

To reduce textile's environmental impact, a series of changes must be incorporated. The materials used in the production of polymers and hazardous chemicals must be replaced with recycled, biobased alternatives that are safe. A smart design can also enhance circularity by encouraging manufacturing methods that use less chemicals and water. To ensure transparency, textile manufacturing companies must mandate that all textiles are labeled to identify what fibers and additives were used during manufacturing. Consumers need to know where their clothes come from and whether or not the method of production is ethical. In recent years, consumer environmental concerns have pressured companies to adopt sustainable practices.

The COVID-19 pandemic has led to a significant increase in e-commerce or online shopping as people shift from in-person shopping to online due to restrictions on physical stores. Despite the opportunity e-commerce has provided for retailers and brands, concerns have also emerged about online shopping's impact on the environment, especially regarding packaging waste and transportation emissions. By offering consumers store credit for selecting a longer expected delivery time instead of a shorter one, e-tailers can encourage consumers to choose an efficient shipping method which may reduce the packaging.

There is a lack of awareness about the environmental impact of fashion choices by common people. Educating consumers about their fashion choices' impacts on the environment is important, which can be addressed with education and awareness campaigns. These can include social media and advertising campaigns, etc.

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Journal of the TEXTILE Association

HANDLOOM

Nettle – A Gift of the Himalayas

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Abstract:

India has the world's best handloom sector which provides employment to over 65 lakhs of weavers. It has high potential to grow further as it permits experimentation while weaving the textile and was flexible and versatile. The beauty of textiles made on handloom cannot be replicated on power looms making it sustainable as ever.

Today the resources were replenishing fast and use of synthetic fibres has increased, we need to move to sustainable alternatives when choosing fibres and fabrics. Himalayan nettle (Girardinia Diversifolia) was a fibre–yielding plant and was the sustainable fibre which was found in the state of Uttarakhand. It as a non-commercial natural fibre which has not been explored much. Studies state that the Himalayan Nettle fibre was the only known longest natural bast fibre. Nettle was an all-season fibre as it has a dual thermal property of warmth and cooling due to the physical structure. Nettle was a wild plant which does not use land which was the resource for cash crops and require little water to grow. No pesticides were required for growing up of the Nettle plant and every part of the plant can be used making it the fibre of the future. Studies have found that Nettle can be an alternative fibre to the cotton and does not harm the environment. But over a period due to the influence of fashion and synthetic fibres, people have stopped using natural resources and have actually moved away from Mother Nature. The conception of green, eco-friendly, sustainable fashion has become the preference of conscious producer and textile consumers.

People have been growing nettle and using nettle, but because of its coarser count and variety, it has not been a part of the fashion seam because of these limitations. Primarily, the people of Uttarakhand were the ones who were producing coarse textile out of nettle plant like ropes, bags, and rugs of this fibre. There has been very less exploration in the weaving of Nettle fabric and therefore the scope of this fibre has been limited. Therefore, as a conscious designer the researcher has endeavoured to bring forward the fibre as a substitute to natural cellulosic fibres and has taken a step forward to bring them back to sustainability which was the future as fast fashion has gripped the entire globe and disconnected us totally from nature. The present study aimed at the development of fabric samples of nettle through exploration in weaving yarn and enhanced it with natural dyes for its aesthetics.

Keywords: *Bast Fibre, Cellulosic, Handloom, Himalayan Nettle, Natural Fibre, Natural Dye*

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1. Introduction

1.1 Nettle: Indigenous Fibre of Uttarakhand

Figure 1 - Himalayan Nettle

Nettle was a wild plant which does not needs to be harvested. The Himalayan nettle was a perennial plant which was found above the sea level approximately between 1300 t0 2800 meters. The people of Uttarakhand have been making coarse textiles out of nettle since many years. The people who were traditionally associated with making the nettle textiles were not practising the craft anymore. Bhotia weaver community, at Mangroli village, Chamoli (UBFDB cluster) has learnt and mastered the technique of nettle fibre processing. (Source: Crafts of Uttarakhand - UHHDC). The people of Uttarakhand have no idea about the design intervention and because of this they could not produce variety of products and reach the potential market. The study also states that weavers possess skills but due to lack of market requirements of products the potential of the weavers was not explored to the fullest. Today there was a need of alternative textile which was sustainable and such one textile was Nettle which was 100% sustainable.

1.2 History

Nettle fibres dates to 2000 years with its traces being found from the late Bronze Age in Voldtofte, Denmark. With the introduction of cotton in the global market, people stopped using natural fibres. During the World War I, the German army used nettle for making uniforms due to the shortage of cotton. Clothing made of nettle fibre was much more comfortable than cotton as nettle fibres were hollow; they were filled.

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Table 1: The Composition of Nettle

Constituents	Composition (%)	
	Dry weight	After degumming
Fibre content of stem	3.5 – 13.2 %	3.5 – 13.2 %
Moisture	16 %	11 %
Cellulose	38 %	67 %
Hemi cellulose	8 %	8 %
Lignin	8 %	4 %
Ash	7 %	3 %

1.3 Properties of Nettle Fibre

- Himalayan nettle was the longest natural bast fibre, i.e. 1.5 m
- It was cellulosic by structure
- It has high breathability
- High moisture content which results in dielectric insulating capacity
- Nettle fibre was antibacterial, antimicrobial, and fire-retardant
- It has great resistance to wrinkling
- Nettle fibre has high tensile strength as compared to cotton and linen, i.e. 1594 MPa
- Nettle plant does not need pesticides to grow and was 100% organic

Nettle fibre was a hollow natural fibre which was its unique property and makes it a different class. The hollow core of nettle creates insulation which was used for winter clothing and when the yarn lengths were twisted and insulation was reduced it was used for summer clothing

Table 1.2: Physical Properties of Nettle

Property	Value		
	Fibre	Yarn	Fabric
Length (m)	1.5	-	-
Diameter (µm)	2.5	-	-
Elongation (mm)	2.7	-	-
Moisture content	158.8 ± 4.2	-	-
Tenacity	-	1594 MPa	
TPI	-	4 - 7	-
Breathability	-	-	High
Crease resistance	-	-	High

(Source: Original Scientific Article / Izvirniznanstveničlanek)

1.4 The uses of Himalayan Nettle Fibre

The 100% nettle yarn was hand spun from Nettle fibres without any additional of chemicals. Traditionally, the nettle yarns were used to make fishing nets, ropes, bags and coarse textiles. Nettle fibres were also used in making arrow shafts by mixing nettle fibres to birch tar and then attaching it to arrowhead.

1.5 Significance

The people of Uttarakhand produce coarse textile out of nettle fibre. The nettle fibre was considered an alternative to cotton as it was a wild plant, no chemicals were used, does not harm the environment. Over the years people have started using synthetic fibres in place of natural fibres and have polluted the nature. Therefore, as a conscious designer the researcher has endeavoured to bring forward the unconventional fibre as a substitute to natural cellulosic fibres and has taken a step forward to bring them back to sustainability which was the future as fast fashion has gripped the entire globe and disconnected us totally from nature. It was important for the researcher too as a new age designer to take this step. The collection of Nettle fabric was crafted to give a new dimension to this unexplored wealth which the state has. People have been growing nettle and using nettle but its coarser count and variety, it has not been a part of fashion scene because of these limitations, so researcher's endeavour was to bring it forward as a fashion fabric. Weaving and natural dyeing was the traditional craft which was inherited by the people of Uttarakhand but due to modernisation, it was no more in use and the researcher has taken an initiative to use these traditional craft for the collection which may revive it.

1.6 Objectives of the Study

- To develop a color palette of nettle yarns using natural dyes.
- To use the Himalayan Nettle for development of different fabric structures
- To explore the possibility of usage of the Nettle fabric for apparel and home furnishing
- To develop a range of fabric samples by utilizing different warp and weft blends and weave structures
- To create executive wear ensemble

2. Methods and materials

2.1 Phase I

2.1.1 Selection of raw materials

Nettle for weft, organic cotton for warp and natural dyes for dyeing the nettle yarns.

2.1.2 Preparation of yarn for weaving

The preparation of yarn for weaving was done using the following processes:

- Bleaching – Nettle yarns were bleached with Hydrogen peroxide to remove natural color of the fibre.
- Premordanting with alum, Cu and Fe2Cl3 at 60 degree for 30 minutes.
- Mordanted nettle yarns were then dyed with alizarin, marigold and pomegranate with various shades ranging from 1% to 9%
- Post dyeing, the yarns were neutralized and finally washed with neutral soap and rinsed and dried.

2.1.3 Development of Weave Samples

The samples were developed on a four shaft handloom. The fabric samples are show in Table 3.1.1

- Warp type : Mill Spun
- Warp Composition: 100% Organic Cotton
- Warp count : 2/40s Ne
- Weft type : Hand-Spun

3.1 The process of making the Nettle fabric: from fibre to fabric

- Weft Composition: 100% Nettle/
- Weft count: 7s Ne

2.1.5 Shortlisting of samples

The developed nettle fabric samples were shown to the panel of internal and external experts at Graphic Era Hill University; Dehradun. The fabric samples were sent to the project sponsor, Raymond, Mumbai for final approval. Finally, the executive wear ensemble was created with the selected nettle fabrics.

2.2 Phase II

Raymond was launching their new range of Khadi as part of "Make in India" initiative with Khadi & Village Industries Commission (KVIC). As the part of that project the current project was undertaken to explore the potential of Himalayan Nettle fibre. In Uttarakhand, the project was given to the researcher to explore the possibility of creating fabric weaves using Nettle fibre of the Himalayan region which is a unique resource of Uttarakhand state. The brief given by the company included:

- Making of an executive wear ensemble with nettle fabric.
- The client was a modern, self-confident, and independent working individual who has the knowledge to appreciate the rich texture and effort put behind a work.
- The theme taken was inspired from the Uttarakhand which has rich heritage and culture.

3. Results and Discussion

The raw material comprised of 100% Nettle yarn and organic cotton yarn. The nettle yarn was sourced from Uttarakhand Bamboo and Fibre Development Board, Dehradun and Organic cotton of 2/40s count from Theba Mill. The shade card for natural dyes was developed. The samples were developed at Bhartiya Gramotthan Sanstha, Dhalwala Rishikesh, Uttarakhand. The production of the Nettle fabric was done at The Jai Shri Phungni Handloom & Handicraft Co-op. Ind. Society Ltd Bhuntar, Himachal Pradesh. 30 samples of Nettle x Organic Cotton were developed in different blend compositions of Nettle and Organic Cotton. Yarns were dyed with natural dyes. The detail of Natural dyes shade card is given in Table 3.1 and of the developed samples is given in Table 3.1.1.

The samples were shortlisted by the internal and external experts of Graphic Era Hill University, Dehradun and then sent to the project sponsor Raymond, Mumbai. Finally, the executive wear ensemble with the selected nettle fabrics was created.

3.1 The process of making the Nettle fabric: from fibre to fabric

Figure 3.1 Processing of fibre to yarn

Figure 3.2 Mordanting process of nettle yarn

Figure 3.3 Natural dyeing of nettle yarn

Figure 3.4 Weaving process of nettle fabric

Table 3.1 Natural Dye Shade Card

SHADE	MORDANT/ DYE	SHADE	MORDANT/DYE	SHADE	MORDANT/DYE	SHADE	MORDANT/ DYE
NDS/101	Alum/ marigold & Pomegranate	NDS/107	Copper sulphate/ marigold & Pomegranate	NDG/113	Ferric chloride/ smokey grey	NDG/119	Ferric chloride/ smokey grey
NDS/102	Alum/ marigold & Pomegranate	NDS/108	Copper sulphate/ marigold & Pomegranate	NDG/114	Ferric chloride/ smokey grey	NDR/120	Copper sulphate/ alizarin
NDS/103	Alum/ marigold & Pomegranate	NDS/109	Copper sulphate/ marigold & Pomegranate	NDG/115	Ferric chloride/ smokey grey	NDR/121	Copper sulphate/ alizarin
NDS/104	Alum/ marigold & Pomegranate	NDS/110	Copper sulphate/ marigold & Pomegranate	NDG/116	Ferric chloride/ smokey grey	NDR/122	Copper sulphate/ alizarin
NDS/105	Alum/ marigold & Pomegranate	NDS/111	Copper sulphate/ marigold & Pomegranate	NDG/117	Ferric chloride/ smokey grey	NDR/123	Ferric chloride/ alizarin
NDS/106	Copper sulphate/ marigold & Pomegranate	NDS/112	Copper sulphate/ marigold & Pomegranate	NDG/118	Ferric chloride/ smokey grey	NDR/124	Ferric chloride/ alizarin

Table 3.1.1: Nettle & Cotton Samples

NTL/101	NTL/106	NTL/111	NTL/116	NTL/121	NTL/126
NTL/102	NTL/107	NTL/112	NTL/117	NTL/122	NTL/127
NTL/103	NTL/108	NTL/113	NTL/118	NTL/123	NTL/128
NTL/104	NTL/109	NTL/114	NTL/119	NTL/124	NTL/129
NTL/105	NTL/110	NTL/115	NTL/120	NTL/125	NTL/130

3.2 Executive Wear Ensemble: Made From Nettle Fabric

Figure 3.2.2 Women executive wear ensemble

Figure 3.2.3 Men executive wear ensemble

4. Conclusion and future scope of study

Further research work is needed in the area of yarn spinning to develop yarn of finer count. Fibre softening can be added process for enhanced feel and appearance. Blending of Nettle fibre with other natural fibres can be done. Hand spinning of the yarn can be improved so that fewer problems are faced while weaving the fabric in handloom. Fastness properties of dyed fabrics (natural dyes) can be quantified and improved if required

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Journal of the TEXTILE Association

SILK

Predicting Pochampally Handloom Silk Saree Purchase Behaviour - A Study on Indian Consumers

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Abstract:

Background: In this study, the purchase behaviour of Pochampally Handloom Silk Sarees (PHSS) is understood and predicted. This study explores whether Purchase Intention mediates Consumer Satisfaction to predict Purchase Behaviour. Further Association with Handloom Products is a moderator to understanding the relation between Consumer Satisfaction and Purchase Behaviour of Pochampally Handloom Silk Sarees. This paper empirically examines the impact of purchase intention on Purchase Behaviour with one product i.e., Pochampally Handloom Silk Sarees.

Methods: The data was collected from 412 respondents (consumers of Pochampally Handloom Silk Sarees) from February 2022 to April 2022 through an online survey method. An empirical examination was conducted using the WarpPLS method.

Results & Conclusion: The analysis of data with WarpPLS reveals a significant relation among the variables is consumer Satisfaction and Purchase Behaviour of the consumer. It confirms that, the mediating effect of Purchase Intention in the association among Consumer Satisfaction and Purchase Behaviour of consumers. It is found that the role of moderator, i.e., Association with Handloom Silk Sarees has a negative impact on Purchase Behaviour.

Keywords: *Association with Handloom Products, Consumer Satisfaction, Purchase Behaviour, Purchase Intention, and WarpPLS*

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1. Introduction :

The Handloom industry is facing the challenge of sustainability in the market due to tough competition from power looms. Another reason could be its failure to attract the consumers and retain them.

The prior literature talks about the studies related to consumer satisfaction, consumer perception, consumer attitudes, and so on for the purchase of handloom products. These articles mostly cover the consumer antecedents, purchase intentions, consumer attitudes, and consumer satisfaction towards handloom products [1, 2, 3, 4]

Less attention was paid and little work was done on empirical studies that looked into the Purchase Behaviour of handloom products especially, Pochampally Handloom Silk Sarees, which is a niche handloom product.

1.1 Research questions of the study

The questions of this research are to test (i) Whether Consumer Satisfaction directly influences the Purchase Intention towards Pochampally Handloom Silk Sarees, (ii) Whether Consumer Satisfaction directly influences the Purchase Behaviour of Pochampally Handloom Silk Sarees, (iii) Is purchase Intention directly influence the Purchase Behaviour of Pochampally Handloom Silk Sarees? (iv) Does Purchase Intention mediate the relation among Consumer Satisfaction and Purchase Behaviour of consumers of Pochampally Handloom Silk Sarees? (v) Whether Association with Handloom Products moderates the strength/ direction between Consumer Satisfaction and Purchase Behaviour of Pochampally Handloom Silk Sarees.

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2. Materials & Methods

The study population comprised Indian Handloom consumers who purchased Pochampally Handloom Silk Sarees at least once. The sample size for the current study was chosen using the statistical tool G*Power analysis, with certain assumptions like 0.15 as effect size and 3 predictors. The study required a sample size of 119, but data were gathered from 412 participants by mailing the structured questionnaire to 526 participants.

The study was conducted using the snowball sampling method [5] which is a non-probability sampling technique. The survey was conducted online. The primary data was gathered using the Survey approach. A total of 27 items comprised demographical data (10 items) and 17 items for measuring the latent variables. They are Consumer Satisfaction (7 items); Purchase Intension (6 items) Purchase Behaviour (4 items) and Association with Handloom Products (1 item). Five-point Likert scale, with a scale of "1- Strongly Disagree to 5- Strongly Agree" was used to assess the replies.

3. Results & Discussion

Initially, descriptive statistics like mean, standard deviation, and correlations were calculated using IBM SPSS 27. The

Table 1- Descriptive statistics

Sl. No.	Latent construct	Mean	SD	Kurtosis	Skewness	CS	PI	CBB	AHP
1	CS-Consumer Satisfaction	3.35	1.13	-0.424	-0.630	1			
2	PI-Purchase Intention	3.10	1.06	-0.730	-0.267	0.680**	1		
3	CBB-Purchase Behaviour	3.89	0.67	0.386	-0.780	0.375**	0.306**	1	
4	AHP-Association with Handloom Products	2.20	1.12	-1.042	0.588	0.279**	0.244**	0.05	1

*Note: (i) ** 'correlation is significant at the 0.01 level (2-tailed)*
(ii) 'Author's compilation based on the findings'

normality of data was examined by the kurtosis and skewness values of the variables which are presented in Table 1. The values of descriptive statistics (Table 1) indicate a moderate degree of correlation among the study variables. A high correlation is observed between purchase intention and Consumer Satisfaction.

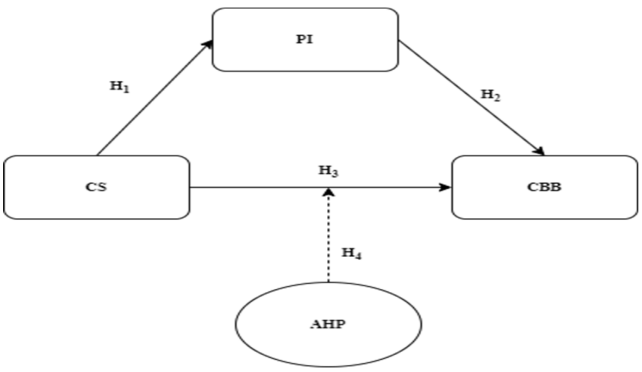

Figure 1- Conceptual model for the study

(NOTE: CS- Consumer Satisfaction; PI- Purchase Intention; CBB- Purchase Behaviour; AHP- Association with Handloom Products).

The data was analyzed based on the conceptual model by using WarpPLS [6] for twin objectives (i) psychometric analysis and (ii) path coefficients significance and predictive relevance.

3.1 Psychometric analysis

The questionnaire for the study was tested for Psychometric analysis i.e., Validity and Reliability and the findings are shown in (Table 2). Reliability was tested with Cronbach α statistic. The Cronbach α value of latent variables taken for the study ranges from 0.62 to 0.93, suggesting that, the reliability of the constructs is within acceptable limits.

Table 2 - Psychometrics statistics (Reliability & Validity)

Sl. no.	Latent construct	No. of items	Cronbach α values	CR	AVE	VIF	DV
1	Consumer Satisfaction	7	0.931	0.945	0.711	2.025	0.843
2	Purchase Intention	6	0.862	0.897	0.594	1.874	0.771
3	Purchase Behaviour	4	0.616	0.776	0.51	1.171	0.689
4	Association with Handloom Products	1	1	1	1	1.128	1

Note: (i) (CR- 'Composite Reliability'; AVE- 'Average Variance Extracted'; VIF- 'Variance Inflation Factor', DV – 'Discriminant Validity
(ii) ('Author's compilation based on the findings)

Convergent (CR) and Discriminant (AVE) validity methods were used to test the validity of data by using Confirmatory Factor Analysis (CFA). The Fornell- Lacker criterion, 1981 was used for testing Discriminant Validity, which means, the square root of Average Variance Extracted (AVE). The present study produces adequate Discriminant Validity for the constructs that are Consumer Satisfaction (0.843), Purchase Intention (0.771), Purchase Behaviour (0.689), and Association with Handloom Products (1.000) which exceed the absolute values of the defined constructs' standard correlation square.

Partial Least Squares analysis was used to test the suggested conceptual model's compatibility with the gathered data, according to the threshold values [7] to test for Convergent validity all the items' loadings are above 0.7. The Convergent and Discriminant validity is sufficiently good in the present study.

3.2 path coefficients significance and predictive relevance

P ath coefficients significance and predictive relevance were performed in two stages i) developing and testing the hypothesis and ii) evaluation of the overall model.

3.2.1 Hypothesis testing

Hypothesis H1

Hypothesis H1 i.e., "Consumer Satisfaction has a significant effect on Purchase Intention of Pochampally Handloom Silk Sarees", represents the direct path in the study. The variable relationship statistics are calculated using partial least squares, the results of the same are shown in Table 3. The table displays the calculated values of path co-efficient, R2, and adjusted R2.

Table 3 - Direct Influence of Variable Customer Satisfaction on Purchase Intention

Description path		Path coefficient	R^2	Adjusted R^2	P value	Result
CS →	PI	0.70	0.483	0.482	<0.001	Significant & Supported H_1

(Note: 'Author's compilation based on the findings)

The direct influence of the Consumer satisfaction Purchase Intention of Pochampally Handloom Silk Sarees is significant at 0.001 levels and the path coefficient is 0.70

Hypotheses H2 and H3

In this section H2 i.e., "Purchase Intention has a positive and significant effect on Purchase Behaviour of Pochampally Handloom Silk Sarees" and H3 i.e., "Consumer Satisfaction has a positive and significant effect on Purchase Behaviour of Pochampally Handloom Silk Sarees" are tested using Partial Least Squares statistics and the results of the same are presented in (Table 4).

The two hypotheses i.e., H2 and H3 represent the direct paths in this study, the variable relationship statistics are tested from the value of the path coefficients and p-values, and the results are shown in Table 4:

Table 4 - Direct influence of variable CS, PI on CBB

Description path		Path coefficient	P value	Result
PI →	CBB	0.163	<0.001	Significant & Supported H_2
CS →	CBB	0.336	<0.001	Significant & Supported H_3

(Note: Author's compilation based on the findings)

The direct influence of Consumer Satisfaction on the Purchase Behaviour of Pochampally Handloom Silk Sarees is significant at 0.001 levels and the path coefficient is 0.336.

Purchase Intention influences the Purchase Behaviour of consumers of Pochampally Handloom Silk Sarees is significant at 0.001 level and the path coefficient is 0.163

Hypothesis H4

To test H4 i.e., the moderation effect of Association with Handloom Products between Consumer Satisfaction and Purchase Behaviour, presented in Table 5.

Table 5 - Moderation Effect of Association with Handloom Products between Consumer Satisfaction and Purchase Behaviour

Description path		Path coefficient	R^2	Adjusted R^2	P value	Result
AHP*CS →	CBB	-0.17	0.26	0.25	<0.001	Significant

(Note: Author's compilation based on the results)

The moderation effect of Association with Handloom Products shows the negative impact with the path coefficient i.e., -0.17 and $p < 0.001$. This is indicating that there is a significant impact of the moderator on the relationship between Consumer Satisfaction and Purchase Behaviour but the direction is negative.

Hypothesis H5

Hypothesis H5 "Purchase Intention Mediates the Effect of Consumer Satisfaction on Purchase Behaviour of Pochampally Handloom Silk Sarees", is formulated. The researcher wants to examine the combined impact of Consumer Satisfaction and Purchase Intention of the consumer on Purchase Behaviour. To check the role of a mediator, Variance Accounted for (VAF) method [8] is used in this study. VAF is calculated as indirect effect/ Total effect. The values of the VAF for mediation analysis are shown in Table 6.

Table 6 - Effect of Mediator PI on CBB

Description of the effects	Path Coefficient
Indirect effect of the path	0.113
Direct effect of the path	0.336
Total effect of the path	0.450
VAF (indirect effect/total effect)	0.251

(NOTE: Author's compilation based on the findings)

The VAF (indirect effect/ Total effect) value is 0.251 or 25.1%. The range of this value is between 20 % and 80 %, meaning that there is partial mediation [8]; thus, it indicates that Purchase Intention has a partial mediation effect among the constructs of Consumer Satisfaction on Purchase Behaviour of the consumer. These findings reveal that Purchase Behaviour is not only influenced by Consumer

Satisfaction but also by Purchase Intention, which mediates Purchase Behaviour.

3.2.2 Overall model evaluation:

The evaluation of the model is done using the Goodness-of-Fit (GoF). This is expressed in terms of Average path coefficient (APC), Average adjusted R-squared (AARS), Average full Collinearity VIF (AFVIF), Tenenhaus GoF (GoF), Sympson's paradox ratio (SPR) and the findings are displayed in Table 7.

Table 7 - Overall Conceptual Model Evaluation indices

Description	Model statistics	Decision
Average Path Coefficient	0.340 (p<0.001)	Accept
Average R-Squared	0.372 (p<0.001)	Accept
Average Adjusted R-Squared	0.369 (p<0.001)	Accept
Average block Variance Inflation Factor	1.260 (<=3.3)	Accept
Average Full Collinearity VIF	1.458 (<=3.3)	Accept
Tenenhaus Goodness of Fit	0.531 (>=0.36)	Accept
Sympson's Paradox Ratio	1 (accept if it is =1)	Accept
R-Squared Contribution Ratio	1 (accept if it is =1)	Accept
Statistical Suppression Ratio	1 (accept if it is >=0.7)	Accept

According to the findings in Table 7, all evaluation indices can be accepted since they meet the standards of all Goodness of Fit. AVIF= 1.260 <=3.3, means there is no multicollinearity problem between indicators. GoF= 0.36, means that the model is fit and very good to use for prediction. The overall resulting model with the values is shown in Figure 2

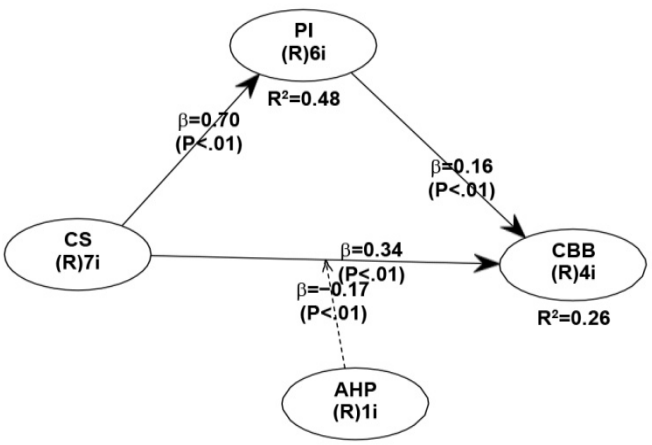

Figure 2: Resulting model with the values using WarpPLS 8.0

3.3 Influence of Consumer Satisfaction on Purchase Behaviour

As per the research results, Consumer Satisfaction had a significant effect on Purchase Behaviour. This can be seen from the values of path coefficient (0.34) and p-value (<0.001) which means that Consumer Satisfaction has a relationship of 34% with the Purchase Behaviour of Pochampally Handloom Silk Sarees. Thus, these results indicate that increasing Consumer Satisfaction is proven to be able to make increase the Purchase Behaviour of Pochampally Handloom Silk Sarees, so that, the alternate hypothesis (H3) can be accepted. Purchase Behaviour has tended to focus on the cognitive (expectations, performance, and disconfirmation) rather than affective components (positive and negative effects) of satisfaction with some notable exceptions [9]. Some authors [10] stated that to keep the business going and revenue increasing, they have to keep the customers satisfied by measuring their Customers' Buying Behaviour patterns from time to time [11]. Consumer Satisfaction acts as a good predictor of purchase behaviour [12].

3.4 Influence of Purchase Intention on Purchase Behaviour

As per the research results, Purchase Intention had a significant effect on the Purchase Behaviour of consumers of Pochampally Handloom Silk Sarees. This can be supported by the values of path coefficient (0.16) and p-value (<0.001) that indicate Purchase Intention has a relationship of 16% with Purchase Behaviour of Pochampally Handloom Silk Sarees, so that, the alternate hypothesis (H2) accepted. Purchase intentions are prerequisites for people willing to adopt certain buying behaviour [13]. Researchers investigate the intention, assuming that Purchase Behaviour will automatically swing along [14].

3.5 Influence of Consumer Satisfaction on Purchase Intention

As per the research results, Consumer Satisfaction had a significant effect on Purchase Intention. This can be supported by the values of path coefficient (0.70) and p-value (<0.001) that indicates Consumer Satisfaction has a relationship of 70% with Purchase Intention towards Pochampally Handloom Silk Sarees, so that, the alternate hypothesis (H1) can be accepted. The study of the consumer judgment process i.e., satisfaction levels is important for understanding consumer purchase intention discovered that customer purchase intention is significantly related to customer satisfaction and perceived product quality.

3.6 Mediating Role of Purchase Intention between Consumer Satisfaction and Purchase Behaviour of Consumers of PHSS

As per the research results, the mediating role of Purchase Intention had a significant impact on Consumer Satisfaction

and Purchase Behaviour of consumers of PHSS. This can be supported by the values of path coefficient (0.45) and p-value (<0.001) indicating that with the mediation of Purchase Intention, Consumer Satisfaction has a relationship of 45% with the Purchase Behaviour of Pochampally Handloom Silk Sarees, so that the alternate hypothesis (H5) can be accepted. Purchase Intention is one of the important factors in predicting the Purchase Behaviour of Pochampally Handloom Silk Sarees [15].

3.7 Moderating Role of Association with Handloom Products on Consumer Satisfaction and Purchase Behaviour

Based on the results from the research, the moderating effect of Association with Handloom Products had a negative and significant effect on the relationship between Consumer Satisfaction and Purchase Behaviour. This can be supported by the values of β = -0.165 and p-value (<0.001) which indicates that the moderation of Association with Handloom Products on the relation between Consumer Satisfaction and Purchase Behaviour of consumers of Pochampally Handloom Silk Sarees has a 16% relationship, so that, the alternate hypothesis (H4) can be accepted.

4. Conclusions

The present study identified that there is a negative moderation observed by the Association with Handloom Products between Consumer Satisfaction and Purchase Behaviour of Pochampally Handloom Silk Sarees. The consumers were satisfied with the attributes like designs, durability, comfort, quality, price, and availability which in turn led to the Purchase Behaviour of the consumer of Pochampally Handloom Silk Sarees. Consumer Satisfaction with Pochampally Handloom Silk Sarees had mediated by the Purchase Intention of Purchase Behaviour. But there is a negative impact of Association with Handloom Products in relation to Consumer Satisfaction and Purchase Behaviour. The study, therefore, suggests that weavers, master weavers, and marketers should concentrate on the attributes of Pochampally Handloom Silk Sarees rather than their association with the selected product. They want to plan the marketing mix strategies to change the negative relation to positive relation with association towards Purchase Behaviour of Pochampally Handloom Silk Sarees.

This study has some limitations also, the sample size of 412, which cannot be considered a large sample, and the inclusion of selected predictors; therefore, there is future scope for researchers to study more predictors of Purchase Behaviour such as consumer awareness, consumer loyalty, brand perception and so on, the study is that cross-sectional nature, in future research; longitudinal study designs can be used to evaluate the proposed model to increase its acceptability. Future studies can get motivated to extend the proposed research model by considering the limitations of this study.

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Journal of the TEXTILE Association

Revolutionizing the Textile Industry through Sustainable Green Technology

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Abstract:

Green technology refers to the development and use of environmentally friendly products and processes to reduce the negative impact of human activities on the environment. The textile industry is one of the largest and most polluting industries in the world, with a significant carbon footprint and a large amount of waste generated. Therefore, there is a growing need for the adoption of green technologies in the textile industry to reduce its impact on the environment. The adoption of green technologies in the textile industry can have a positive impact on various stages of the production process, including raw material production, yarn manufacturing, fabric production, dyeing and finishing, and waste management. Some examples of green technologies that can be used in the textile industry include organic and recycled fibres, low impact dyes, and water and energy-saving processes. The use of organic and recycled fibres can help reduce the environmental impact of textile production by reducing the use of pesticides and fertilizers in agriculture and reducing the amount of waste sent to landfills. Low impact dyes are also an environmentally friendly alternative to conventional dyes, as they require less water and energy and produce fewer harmful chemicals. In addition, water and energy-saving processes can help reduce the number of resources used in the production process, thereby reducing the carbon footprint of the textile industry. Overall, the adoption of green technologies in the textile industry can help reduce its negative impact on the environment and promote sustainable practices.

Keywords: *Green technology, Eco-friendly process, Textile industries, Green textiles*

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1. Introduction :

Consumers are looking for healthier lifestyle options due to global pollution and rising awareness. Consumers today are more concerned about their health and actively promote greener lifestyles. Green or eco-friendly production involves practises like minimising and recycling. The non-toxic clean products and energy production strategies are the focus of the green system field. This technology can bring about innovation and change in daily life without harming the environment or compromising its sustainability. It is difficult to foresee how the technologies can be contained in this regard. There haven't been enough studies done in this field when the green textile and apparel sector is considered. Moore and Asley provided an illustration of how stakeholders working together might lead to greener production and boost productivity [1].

Fuzzy logic and the analytical hierarchy process were combined by Wang et al. to create a selection (decision-making) model for various green initiatives in the fashion industry [2]. Wu, et al. analysed Taiwan's textile and clothing producers and looked at the connections between organisational supports, social capital, and government involvement, green purchasing, consumer cooperation, eco-design, and investment recovery practises. This research focused on potential methods that could be used to enhance the general environment and working conditions in the textile sector. Furthermore, based on the green technology applications. The youthful, non-green textile sector can be changed to one that is more environmentally conscious and sustainable. According to the definition of a green environment, the analysis of the textile industry and lifecycle and the critical function of greening parameters are covered.

2. Materials & Methods

By enhancing the entire environmental and manipulation aspects of the textile industries with some focus on achieving an internationally recognised standard, the green technology in industrial textile can be improved. This article covered the textile industry's environmental benefits. The study of green technology focused on how much more environmentally friendly textile manufacture, use, and recycling would be. Additionally, by offering a major method to identify green businesses with low-cost measurement, this work aimed to ascertain the significances of green textiles industries in terms of both economic and environmental benefits. The textile industry has traditionally been associated with high levels of resource consumption, pollution, and waste. However, with the growing awareness of the environmental impacts of textile production, there has been a significant shift towards the use of green technologies and techniques that are more sustainable and eco-friendlier. By strengthening the whole environmental and manipulation aspects of the textile industries with some focus on obtaining an internationally recognised standard, the green technology in industrial textile can be improved. This article covered the

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textile industry's benefits for the environment. The study of green technology centred on how much more environmentally friendly textile production, use, and recycling would be. Additionally, by offering a major method to identify green businesses with low-cost measurement, this work aimed to ascertain the significances of green textiles industries in terms of both economic and environmental benefits [3]. Here are some examples:

2.1 Water-saving techniques

The textile industry is one of the largest consumers of water, with the dyeing and finishing processes alone using vast amounts of water. Green technologies like advanced dyeing processes, such as air dyeing and foam dyeing, and water recycling systems can help reduce the industry's water consumption. The textile industry is known for its high water consumption and environmental impact. However, there are several water-saving techniques that can be implemented in the textile industry using green technology. Here are some examples:

2.2 Recycling water

One effective technique is to recycle and reuse the wastewater generated during textile production. This can be done through various methods such as reverse osmosis, nanofiltration, or ultrafiltration. By reusing water, the amount of water used in the production process can be significantly reduced [4].

2.3 Eco-friendly dyes

Traditional textile dyes are known to be harmful to the environment due to their high chemical content. Eco-friendly dyes, on the other hand, are made from natural materials and are free from harmful chemicals. Recent research has revealed that some of these fibrous plants are rich suppliers of phytoestrogens as well as potentially effective natural medicines. More fashion and clothing companies are switching to eco-friendly textiles nowadays, with the justification being that no pollutant must be used throughout any stage of the textile's manufacture. Textiles may still reduce their environmental impact, whether in manufacture, distribution, or agriculture. The first phrase that may be used for the actual development of environmentally friendly textiles in this context is "green technology." The term "green technology" refers to a variety of procedures and goods that range from non-toxic cleaning agents to energy generation systems. Cleaning agents to energy generation systems [5].

Table 1: Estimated global tonnage of fibrous raw materials from agricultural crops

Crop	Plant component	Availability 000 tonnes
Cereals	Straw	
Barley	Straw	222.5
Oats	Straw	52.8
Rice	Straw	475.3
Rye	Straw	51.9
Wheat	Straw	749.7
Corn	Stalks	737.0
cotton	Mote	800
Bast Fibrous Plants	Straw	26
Seed grass	Straw	2
Oil Flax	Straw	3
Sorghum	Stalks	104.7
Sugarcane	Bagasse	100.2

2.4 Low water-use machinery

There are many types of machinery used in textile production, some of which use a lot of water. Low water-use machinery can be used instead, which reduces the amount of water needed for production. For example, some washing machines use less water by recycling the water within the machine.

2.5 Waterless processes

Some processes in textile production can be done without using any water at all. For example, some printing processes use heat transfer or digital printing instead of traditional screen printing, which requires water.

2.6 Rainwater harvesting

Textile companies can collect rainwater and use it for non-potable purposes such as cleaning, gardening, or cooling equipment. This reduces the demand for fresh water and lowers the company's overall water footprint. By implementing these and other green technologies, textile companies can significantly reduce their water consumption and environmental impact while still producing high-quality textiles [6].

2.7 Renewable energy sources

The textile industry is also a significant consumer of energy, primarily fossil fuels. The use of renewable energy sources like solar and wind power can help reduce the industry's carbon footprint and make textile production more sustainable. The textile industry is a significant consumer of energy and resources, and transitioning to renewable energy sources can help reduce its carbon footprint and contribute to sustainable development.

Figure 1: Eco friendly materials and their importance

2.8 Natural dyes

Natural dyes, on the other hand, are generally safe and pose fewer risks to human health. This makes textiles dyed with natural dyes a healthier and more appealing choice for consumers.

- Consumer Demand for Sustainable Products: In recent years, there has been a growing demand for sustainable and eco-friendly products, including textiles. Consumers are becoming more conscious of the environmental and social impacts of their purchasing decisions. By using natural dyes, textile manufacturers can cater to this demand and differentiate their products in the market.
- Collaboration with Farmers and Artisans: The shift towards natural dyes requires collaboration between textile manufacturers, farmers, and artisans. Farmers can cultivate dye-producing plants, ensuring a sustainable supply chain. Artisans skilled in natural dyeing techniques can contribute their expertise, promoting fair trade practices and supporting local economies.
- Research and Development: Further research and development in natural dye extraction, dyeing techniques, and colour fastness can improve the overall performance and durability of natural dyes. Innovations in this field can address some of the challenges associated with natural dyes, such as colour fading and limited shade range, making them more viable for large-scale textile production [7].

In summary, the use of natural dyes has the potential to transform the textile industry by promoting sustainability, preserving traditional knowledge, offering a diverse colour palette, enhancing consumer health and safety, meeting consumer demand for sustainable products, fostering collaborations, and driving research and development. By embracing natural dyes, we can create a more environmentally friendly and socially responsible textile industry.

2.9 Sustainable fibres

The use of sustainable fibres like organic cotton, hemp, bamboo, and recycled polyester can help reduce the environmental impact of textile production. These fibres are grown without the use of harmful chemicals and pesticides, and they require less water and energy to produce [8].

Fig:2 Types of Sustainable Fibres

2.10 Waste reduction and recycling

The textile industry generates a significant amount of waste, including scraps of fabric and unused material. The use of recycling techniques like closed-loop production and upcycling can help reduce waste and conserve resources. Waste reduction and recycling are important aspects of sustainable development, and the textile industry has a significant impact on the environment. Green technology offers innovative solutions for reducing waste and increasing recycling in the textile industry [9]. Here are some ways that green technology can be used to reduce waste and increase recycling in the textile industry:

a) Use of Sustainable Materials: Textile manufacturers can use sustainable materials such as organic cotton, hemp, bamboo, and recycled polyester to reduce the environmental impact of their products. These materials are grown without the use of harmful chemicals and can be recycled or biodegraded at the end of their life cycle.

b) Water Conservation: The textile industry is a water-intensive industry, and green technology can be used to reduce water consumption. Some techniques such as digital printing, dyeing, and finishing can help in reducing water usage up to 90%.

c) Chemical Management: The use of toxic chemicals in textile processing is a major environmental concern. Green technology can help textile manufacturers to use eco-friendly alternatives such as natural dyes, enzymes, and biodegradable chemicals.

d) Recycling and Waste Reduction: Green technology can help in the recycling of textile waste such as post-consumer waste and post-industrial waste. Textile waste can be repurposed for different purposes such as insulation, furniture padding, and carpet backing.

e) Energy Efficiency: The textile industry is energy-intensive, and green technology can be used to reduce energy consumption. Use of renewable energy such as solar and wind power can help in reducing the carbon footprint of the industry.

In conclusion, the textile industry can reduce waste and increase recycling by using green technology. The use of sustainable materials, water conservation, chemical management, recycling and waste reduction, and energy efficiency can help the industry to move towards a more sustainable future. Overall, the textile industry can significantly benefit from the use of green technologies and techniques. By reducing water and energy consumption, using sustainable fibres and natural dyes, and implementing waste reduction and recycling techniques, the industry can become more sustainable and environmentally friendly.

3. Results & Discussion

The possibilities to transform textiles were examined in this study, industry into the green textile sector has occurred in two stages created. It is anticipated that by comparing the price of making a garment in the nongreen textile industry with the green textile industry, that green textiles have lower production costs. The price of clothes Because of the limited production, for green textile industries is less [10]. Green technology and circular economies are therefore the most important vital techniques for making textiles that are respectable, durable, and green of the surroundings.

3.1 Resent Progress on Greening Textile Industry

Making factories environmentally or eco-friendly is gaining importance internationally since the globe is becoming more susceptible for its inhabitant's day by day. Worldwide, unhealthful environments claim millions of lives each year. According to a new World Health Organisation report, environmental dangers now have a role in more than 100 of the most severe diseases and injuries in the world and account for 12.6 million fatalities year, or 23% of all deaths. In this case, green manufacturing is essential, and the idea should be encouraged. Interesting enough, a certification programme called Leadership in Energy and Environmental Design (LEED) was created by organisations like the U.S. Green Building Council (USGBC) to assess a building's environmental performance and promote market adoption.

3.2 Economic advantages

If non-green industry is transformed into green industry, the following financial advantages will result.

- The working conditions and environment in factories are highly valued by well-known companies.
- Western consumers also favour purchasing goods made in environmentally conscious factories. Boost output and develop a brand image.
- Though establishing a green factory requires a 30 to 40% higher initial investment than a conventional one, it ultimately saves money by lowering the cost of utilities like power and water.
- Although adopting eco-friendly or green technology initially needs large investments, such a move may assist boost the country's competitiveness. For environmentally friendly items, buyers typically offer 10 to 15 percent more prices.

4. Conclusion

This study's goal was to assess the current state of raising awareness of the need for greener manufacturing in the textile industry. Industries must modify their current products due to the competitive climate. In the textile sector, there is a duty to practise environmental responsibility. The present green technology that might preserve the environment without having an impact on the textile industries was described in this paper. As a result, the most important variables in making textile and garment production more ecologically friendly are those that start with the product design stage, raw material selection, processing and production decisions, transportation, retailing, and waste management. Additionally, this article discussed current green technology research as well as available textile industry methods. Finally, it was determined that green technology in the textile industry can guarantee the environmental sustainability and friendliness.

5. Conflict of Interest

Author declares no conflict of interest.

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PROCESSING

Wicking Performance of C-Shape Filament Yarn for Comfort Fabrics

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Abstract:

Clothing has a huge impact on comfort and physiology when participating in sports such as running, cycling and hiking and other outdoor activities. Three factors—psychological, tactile, and thermo-physiological—can be used to categorize clothing comfort. Functional clothing, especially sports and activewear, needs to have fabric moisture management properties like sweat absorption, distribution, draining, evaporation and drying in order to work properly and be comfortable. The absorption, distribution, evaporation, and drying properties of synthetic textiles are significantly influenced by the rate of moisture dispersion, or wicking. Fibres in apparel can have an impact on the wearer's comfort. The primary goal of this research is to look at the effect of the C shape cross section filament yarn on the wicking ability of polyester fabric. In this study, the wicking ability of polyester filament yarn of circular cross sections compared with the C Shape cross sections filament yarn. The experimental results show that the C Shape filaments perform better in wicking tests than circular cross section filaments. The better wicking of C Shape filaments can be attributed to two factors: first, the increased surface area for capillary action, and second, the micro and liner capillaries created inside the C Shape cross section of the filament.

Keywords: *C-Shape Filament Cross Sections, Capillary Flow, Comfort, Profile Filament, Wicking*

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1. Introduction :

Comfort is regarded as a critical component in the development of functional clothes. Various attempts have been made to evaluate and describe human garment comfort. Clothing is said to as a second skin, and it is quite vital in everyday life for feeling comfortable. Humans have acquired an interest in clothes for various activities such as jogging, hiking, and rock climbing in recent years, and are aware of its comfort and functionality [1].

The most significant aspect of clothing is its comfort, which can be divided into three categories: psychological, tactile, and thermo-physiological. Psychological comfort has nothing to do with fabric characteristics and is primarily determined by societal fashion trends. Tactile comfort is primarily determined by how much stress is generated in the fabric and how it is distributed across the skin, and it thus has a significant relationship with both mechanical and surface qualities of fabric. The fabric handle has a direct relationship to tactile comfort. Thermal comfort is related to the fabric's ability to maintain skin temperature and allow perspiration to be transferred from the body. Thermal resistance, air permeability, water vapour permeability, and liquid water permeability are recommended as crucial for a body's thermal comfort [1].

Fabric moisture management qualities, such as sweat absorption, distribution, evaporation, draining, and drying, are crucial to the performance and comfort of functional garments, particularly athletics and activewear. The rate of moisture dispersion, or wicking, has a significant impact on the qualities of synthetic textiles such as absorption, distribution, evaporation, and drying. Fabrics having a higher wicking rate absorb more moisture and transport it to a broader surface area, resulting in faster drying and higher comfort levels. As a result, the best wicking behaviour in fabrics is required to achieve clothing comfort, particularly in sportswear [2-4].

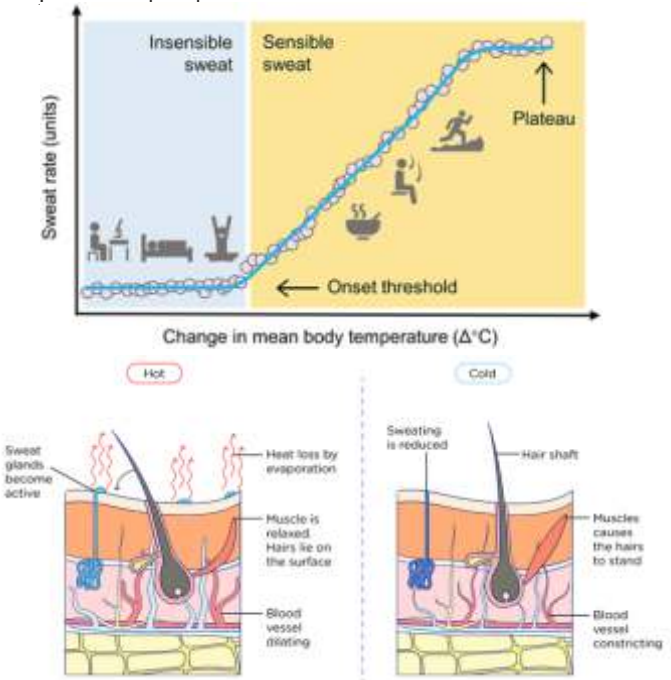

Figure 1: The relationship between change in mean body temperature and sweat rate with mechanism of body thermoregulation [5]

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Figure 1 shows how the body's thermoregulation process affects the relationship between sweat rate and mean body temperature change. The main loss of physical sweat under the onset threshold is insensible sweat (office work, relaxing, yoga, etc.). After the onset threshold (running or high-intensity activity), liquid or visible sweat predominates. The optimal sweat rate peaks even if the body temperature climbs more. Sweating can cause some of the body's liquid and vapour (hygroscopic) fluids to be absorbed by clothing. Sweating evaporates from the skin or clothing, causing cooling [5].

1.1 Fibre parameters and thermo-physiological Comfort

By carefully choosing clothing material and construction specifications, the energy balance between the human body and environment required for physiological comfort is modified in a way that is beneficial, highlighting the fact that functions of clothing are crucial to man in all environments, especially extreme weather conditions [6].

Because of its beneficial characteristics, such as high strength, dimensional stability, ease of maintenance, and wrinkle-free qualities, polyester fibre is the most frequently and widely used fibre. However, 100% polyester and textiles rich in polyester are uncomfortable to wear due to their hydrophobicity. over the world, some initiatives have been made to get over this polyester limitation by altering the fibres' external forms. In this sense, fibre cross-sectional forms and fineness have been the main topics of research for fabric designers as they relate to wear comfort. Since polyester fibres have a poorer thermal conductivity than other fibre types, warmth is retained longer when the fibres are hollowed out or grooved [7, 8].

Particularly in wear scenarios when substantial sweating occurs, the lower dtex of microfibers showed to be physiologically favourable. Wetting and wicking is the most efficient method for preserving a comfortable feeling in sweaty conditions. When wearing clothing with strong wicking abilities, moisture from the skin is dispersed throughout the material, leaving the wearer feeling dry and facilitating quick evaporation of moisture [9].

One of the most important aspects of a textile is how it reacts to water or liquid in general. Wetting of fibre materials can have a considerable impact on both the performance of materials after ultimate use and multiple production processes. Liquid moisture flows through textiles due to fabric-liquid molecular attraction at the surface of the fibre materials, which is principally determined by surface tension and effective capillary pore distribution and pathways. Wetting and wicking are two mechanisms that allow liquid to pass through a porous surface in a sequential manner. Wetting is the first step in the diffusion of a fluid. In this technique, the fiber-liquid interface replaces the fiber-air interface.

$$\gamma_{SV} - \gamma_{SL} = \gamma_{LV} \cos\theta \ldots\ldots (1)$$

Here, y represents the tension at the interface between the various combinations of solid (S), liquid (L) and vapour (V), and q is the contact angle between the liquid drop and the surface of the solid to be wetted.

In this equation, y represents the tension at the interface of various solid (S), liquid (L), and vapour (V) combinations, and q is the contact angle between the liquid drop and the surface of the solid to be wetted.[10], [11]

Direct correlation exists between the contact angle and the fabric's wetability. The degree of wettability is high when there is little contact between the fibre and the liquid. When the apparent wetting angle decreases with increasing surface roughness, it is because of the troughs that rough surfaces produce that water spreads across the surface more quickly. Because the surface's chemical composition influences the wettability of the substance, as hydrophilicity increases, the contact angle decreases and surface wettability increases.

The best method for retaining a comfortable feeling when perspiring is wicking. When wearing clothing with strong wicking abilities, moisture from the skin is dispersed throughout the material, leaving the wearer feeling dry and facilitating quick evaporation of moisture. The capillary pressure is created when the liquid penetrates the gaps between the fibres and wets them. The meniscus's curvature in the tiny spaces between the pores causes the liquid to be driven by this pressure and dragged along the capillary. Wickability is the capacity to maintain capillary flow. The Laplace Equation 2 provides the capillary pressure's magnitude.

$$P_c = \frac{2\pi r \gamma_{LV} \cos\theta}{\pi r^2} = \frac{2\gamma_{LV} \cos\theta}{r} \quad \ldots\ldots\ldots\ldots (2)$$

The capillary pressure created in a capillary tube with a radius of r is denoted by P_c in the above formula. The distribution of the fluid in the media is caused by a variation in capillary pressure in the pores. Since the pressure inside the capillary is higher the smaller the pore size, the earlier it fills. The smaller holes are the last to empty during capillary draining under external pressure. Only capillary forces may be responsible for the movement of liquid into a fibrous construct, as a yam or cloth. Liquid is drawn into the gaps between the capillaries by capillary forces. Yarns and textiles have different capillary gaps. Additionally, the surfaces and pore walls of fibrous materials have roughness [10-12].

Even though it doesn't spread over the smooth surface of the same solid, a liquid can spread along ridges or rugosities on a surface. The driving force behind this surface wicking depends on the geometry of the grooves, the liquid's surface tension, and the free energies of the solid-liquid and solid-gas interfaces. When discussing capillary flow in fabrics theoretically, fibrous assemblies are typically thought to be made up of many parallel capillaries. In a non-homogeneous capillary system, such a fibrous construction, the liquid moves discontinuously.

The uneven capillary gaps' varying diameters induce the wetting front to enter the capillary system in tiny jumps. The pace of wicking is crucial because the majority of textile processes have time constraints. However, there are other elements besides interfacial tensions and fibre wettability that can affect the wicking rate. The capillary dimensions of the substrate, which rely on the shape and geometry of the fibres, determine the wicking rate [13-15].

For capillary action to occur, the cumulative pressure inside the capillary tube must be greater than liquid gravity. The related expressions are those found in equation (3).

$$\frac{2\gamma_{LV}\cos\theta}{r}\pi r^2 - \pi r^2 h\rho g > 0 \quad \ldots\ldots\ldots(3)$$

Where h, r, g, and r #tand for the capillary liquid height (m), equivalent capillary radius (m), gravity acceleration (m/s^2), and liquid density (kg/m^3), respectively. likewise q#theta and q_{LV} represent the liquid-gas contact angle and liquid-vapor interfacial tension, respectively, at 20 °C, where water has a value of 0.0725 (N/m).

$$h = \frac{2\gamma_{LV}\cos\theta}{r\rho g} \quad \ldots\ldots\ldots(4)$$

The greater the capillary equivalent radius, the smaller the wicking height (h). [12], [13]By modifying cross sections, creating micro cross sections, and improving yarn compactness, the capillary's radius may be reduced. The influence of C Shape cross section on the wicking behaviour of polyester filament yarn is examined in the current study in comparison to filament yarns with circular cross sections.

2. Materials and Methods

On the melt spinning apparatus seen in figure 2, the Bombay Textile Research Association lab in Mumbai created the polyester filament yarns with circular and C-shaped cross-sections. The number of filaments and the diameter of the filaments were maintained for both circular and C-shaped cross-sections. The information on spinneret profiles and the manufacturing process parameters are provided below.

Figure 2: The pilot melt spinning machine used to develop filaments yarns

2.1 Manufacturing process parameters

- Melt Spinning – Textile Equipment Co. Delhi
- Spinning Temp- 220 oC
- 195,210 and 215 oC of 3 Heater

To estimate the filament diameter and cross-section form, the yarn samples are measured using an electronic microscope. The observed C-shaped filament yarn sample is displayed in a microscopic view.

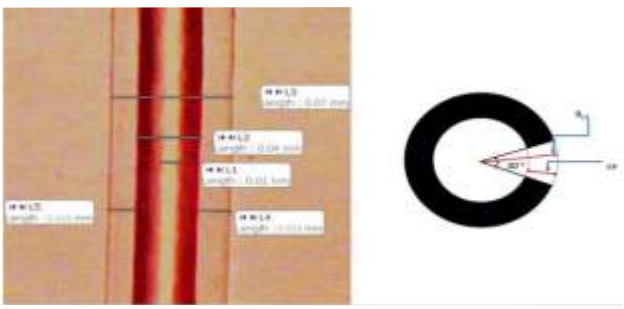


Figure 3: Microscopic image of the C Shape filament yarn

The average diameter of round and C-shaped filaments measured under a microscope at ten different locations for each filament. The occurrence of Hollo open voids in the cross sections, like to the letter "C" in the alphabets, gives C-shaped cross sections their name. Filaments with solid circular cross sections are depicted in these cross sections. Table 1 lists the specifics of the properties assessed on the yarn.

Table 1- Dimensions of Circular and C-Shaped filament

Circular Cross-section Filaments		C Shape Cross-section Filaments				
Sample	Diameter	Sample	Outer Diameter	Inner Diameter	θc	Thickness of curve C
1	0.07 mm	5	0.07 mm	0.04 mm	30°	0.015 mm
2	0.09 mm	6	0.09 mm	0.06 mm	30°	0.015 mm
3	0.11 mm	7	0.11 mm	0.07 mm	30°	0.02 mm
4	0.13 mm	8	0.13 mm	0.09 mm	30°	0.02 mm

2.2 Vertical Wicking Test of Yarn Samples

The vertical wicking height of all eight samples was measured with regard to time using a vertical wicking test setup as shown in figure 4. All four samples of same cross section tested for wicking performance together, using the experimental setup with a frame on which yarns are hold with uniform tension. The entire process, from the start of the wicking process to the water reaching equilibrium in the yarn, has been documented. To improve the visual clarity of the flow, 3 g/l Procion blue reactive dye was added to the water used in the experiment.

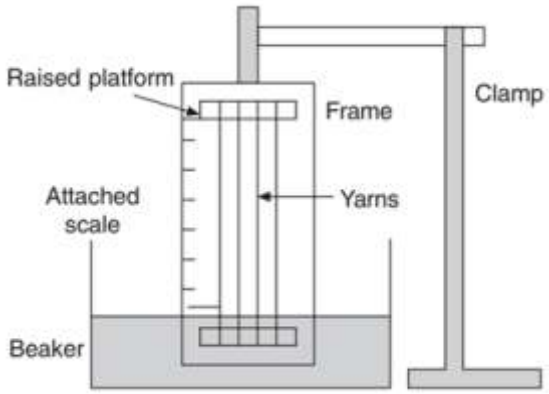


Figure 4: Experimental setup for yarn vertical wicking test.[16]

3. Results and Discussion

Tables 2 and 3 demonstrate the maximum wicking heights of filament yarns with circular cross sections and C shape cross sections determined from the experimental data. It indicates that, i) for both circular and C Shape filaments, finer filaments have a higher maximum wicking height than coarser filaments. ii) Circular filament yarns have a lower maximum wicking height than C shape filament yarns of the same outer diameter.

Table 2 - Maximum Wicking Height of circular filament yarn

Sr. No	Number of Filaments	Diameter of Circular Cross-section Filaments	Maximum Wicking Height mm
Sample 1	35	0.07 mm	44
Sample 2	35	0.09 mm	40
Sample 3	35	0.11 mm	34
Sample 4	35	0.13 mm	31

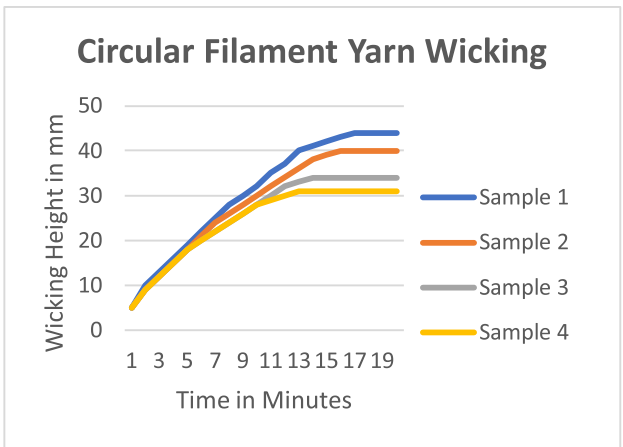
Table 3 - Maximum Wicking Height of C Shape filament yarn

Sr. No	Number of Filaments	Dimensions of C Shape Cross-section Filaments				Maximum Wicking Height mm
		Outer Diameter	Inner Diameter	θc	Thickness of C Curve in	
Sample 5	35	0.07 mm	0.04 mm	30°	0.015 mm	64
Sample 6	35	0.09 mm	0.06 mm	30°	0.015 mm	58
Sample 7	35	0.11 mm	0.09 mm	30°	0.02 mm	53
Sample 8	35	0.13 mm	0.11 mm	30°	0.02 mm	46

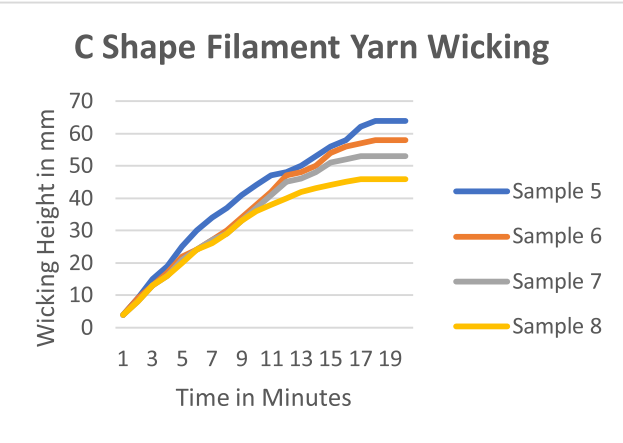
First observations about higher wicking height in finer filaments have already been published in study journals by several researchers. Finer filaments generate finer capillaries in the yarn structure, resulting in higher wicking height in finer filaments than coarser filaments. This is true for both circular and C-shaped filament yarns.

The second finding shows that C-shaped filaments wick more effectively than circular filaments. This is because the C-shaped filaments have a bigger surface area where wicking capillaries can form. As illustrated in figure 3, yarn with circular filaments forms capillaries with the outer borders of the filaments near to one another, in contrast to C shape filaments, which form capillaries with both the inner core and the outer boundaries of the filaments adjacent to one another.

Figure 5 depicts the wicking behaviour of the C shape and circular cross section filament yarns as seen in the vertical wicking experimental test of the filament yarns. All four samples' observed wicking heights in circular filaments are identical up to 6 minutes, at which point sample 1's finer filaments continue to wick at the same rate for an additional 17 minutes. The sample 2 continues to wick at a somewhat slower rate than the sample 1 does up to a 15-minute mark. Both samples 3 and 4 exhibit a similar wicking pattern, however at a slower rate that lasts for 13 and 10 minutes,



(a)



(b)

Figure 5: Graphical representation of wicking height for a) Circular cross section filament yarn and b) C Shape cross section filament yarn

respectively.

The circular filament in sample 1 has an outer diameter of 0.07 mm, and when compared to the C-shaped cross-section filament in sample 5, which has an outer diameter of 0.07 mm, the wicking behaviour shows that both filaments have the same outer diameter, but the C-shaped cross-section filament provides continuous wicking rate for a longer period of time than the circular filament. After 5 to 7 minutes, the wicking rate in circular filaments slows down, and the maximum wicking height is reached after another 11 to 14 minutes of wicking. Wicking proceeds at a constant rate in the C-shaped circular filaments until the maximum level of wicking is reached. Due to continuous capillary that has formed inside the C Shape, the filament in this shape is continuous. As a result, water can rise until the acceleration brought on by gravity acting on the water molecule equalises the capillary pressure. However, in the case of circular filaments, the walls of the adjacent filaments serve as capillaries. These capillaries vary in diameter depending on where they are located, and because of twist or torsion, they shift direction at an angle from the yarn axis. Circular filaments exhibit a decrease in vertical wicking rate after a given height due to the capillaries' altered axis, which causes wicking to occur less precisely in the vertical direction.

4. Conclusion

The experimental investigation to determine the influence of their cross sections, i.e. circular and C shape, on wicking behaviour. Filaments with C shape cross sections have a higher maximum wicking height as well as wicking rate than the circular filaments. In comparison to the C Shape filaments, this reduced the wicking performance of the circular filaments. According to the findings of this study, C shape filaments have greater wicking ability than circular filaments and can thus be utilised in sportswear materials where a higher wicking rate for sweat spreading is required. The rapid distribution of perspiration across the cloth provides a vast surface area for sweat evaporation into the atmosphere, resulting in rapid drying. This fast spreading, evaporation, and drying of perspiration results in increased

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HANDLOOM

Development of Textiles in Ramayana

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Abstract:

As the Ramayan Era is too old i.e., thousands of years back, some people used to say it mythology but it's not a myth. We can observe so many geographical proofs of Ramayana right from Ayodhya -Panchvati -Ramsetu to Shri-Lanka and when you will read it and study you will find amazing facts related to industrial development also. Here we are limiting ourselves up to the development in textiles only. The points related with textiles are limited in Ramayana but the development related with types of fabrics, value addition is surprising. Here, we will go with original Sanskrit Shlokas (verses) one by one to get the information. Note: We are sticking with Valmiki Ramayana (Geeta Press, Gorakhpur) strictly.

Keywords: *aayodhya, Adyaya, kand, ramayan, shloka*

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1. Introduction :

Ramayana is poetic biography of 'ShriRam', the king of Aayodhya written by Maharshi Valmiki in Sanskrit language. It is thousands of years old. (About number of years there is dispute, nobody can tell perfectly). In this biography seven big Chapters called as 'kand' are there like- 1) Balkand 2) Ayodhyakand 3) Aaranyakand 4) Kiskindhakand 5) Sundarkand 6) Yuddhakand and 7) Uttarkand. In these kands, many small chapters called as 'Sargas' are included and these sargas are having number of Shlokas.

For searching these glimpses of Textiles, we have read every shloka and found some significant facts related with development in textiles. This was a gaint task.

Here, we are putting the study in short through following sequence A) Types of fabrics in Ramayana B) Value addition ideas C) Textile products excluding clothing D) A land having Sericulture.

A) Types of fabrics developed in Ramayana:

While studying, we though found the maximum use of silk in clothing, we also found that cotton fabric was also there. The use of skin of a tree is also there but were used for special purpose of going to forest i.e. for vanavasa, we will see one by one.

I. Silk: As Ramayana is story of Kings, silk clothing was used more and more for example.

'Athatma Paridhanarth Sita Kausheyavasini' Shlok 9, Sarg 37, Ayodhyakand'

Here, 'Vasas' means vastra or clothing. Kausheya means derivated from Kosha i.e. nest of a honey bee i.e. silk.

'Seetayaha Kausheyasya pari.' Shlok 14, Sarg 37, Ayodhyakand'

Like this, use of silk for apparels is found there and it is the tradition of Enshant Bharat.Special for devotional rituals, silk is used for so many years.

ii. Cotton: With silk, cotton fabric was also there in use. We found one shloka showing the matter was like this-

'Veshtante tasya langulam jirnaihi karpasikaihi pataihi II Shlok 6, Sarg 53, Sundarkand'

It means to follow the order of 'Ravan' all the servants of him, started winding Hanumanas tail with older cotton cloth.

iii) Skin of trees: These wearing were wellknown as 'Valkal' or 'CheerVastra'. The tribals and Hrishis living in forest were wearing these cloths. We will get its references like this-

'Athatmaparidhanarth Sita Kousheyvasini । Sampreksh Chirn Santrasta Prushati Vaguramiv II
Shlok 9, Sarg 37 Ayodhyakand'

It means, when Sita became afraid as she has been asked to wear those rough cloths made by treeskin (Chirvastra) because she had habit to wear silk. Thus, there are references of these three types of fabrics.

B) Value addition ideas in Ramayana:

It is really very surprising observing the modern ideas of textiles used in a history of Ram thousand years back. We will see it now.

We found two remarkable ideas 1) Apparel with flower decoration 2) Saree with Border

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i) Apparel with flower decoration:

When Ravan visited Sita to propose her again, he worn very impressive Dhoti. it is mentioned like this.

'Mathitamrutafenabhamrajovastramuttamam ।
Sapushpamavakarshantm saktamangade II Shlok 24, Sarga 18, Sundarkand'

It means like this – His (Ravan's) wearing was just like colour of fresh butter with high quality. Flowers were attached to his dhoti. At this moment, the dhoti was entangled with the ornaments in his hand and he was trying to make it free.

Thus, this attachment of marval and flowers is really surprising.

We will see another example. It is like this…

'Niljimutsankashan Hemsanchaditambaram II Shlok 5, Sarg 40, Yudhakand'

i.e. Ravan was looking like dark cloud. He wore the dhoti with golden decoration. In ancient Bharat, it was well known fashion to use gold and silver yarn with silk for decoration purpose. It was well known as 'Jarikam'.

ii) Saree with Border

Yes! In those days border of different colours was also used and it was used by 'Anjana' i.e. mother of Hanuman. It is mentioned with birth story of Hanuman like this.

'Tasya Vastram Vishalakshyha Pitam Raktadsham Subham।' Shlok 12 Sarga 66 Kishkindhakand'

Jambhavan says that the lady with bigger eyes worn yellow saree with Red border. After observing these important features of apparels or wearing of human being will try to find other products.

C) Textile products :

In Ramayana we have found two three other products related with textiles. We will see one by one.

i) Bed sheets: In Sundarakand, there is information related with bed used by Ravan and silk bedsheet was used on it.

'Maharhastarapetairuppannam Mahadhaneihi I' Shlok 2, Sarg 10, Sundarkand'

Means costlier bed sheets were used on that bed.

ii) Royal Umbrella (Shwet Chatr)

The royal umbrella of white colour was used by Kings in Ayodhya and Lanka also. Here, we see it with Vibhishan in Lanaka.

Ekstatra Maya drustaha Shwetchatro Vibhishanana I Shlok 32, Sarg 27, Sundarakanad'

I have seen only Vibhishan with white umbrella. With this we found rope also.

iii) Rope: Before going to forest for fourteen years, Ram donated everything he was having. Speaking about that he says:

'Yo hi datwa dwipshreshtam kakshayan kurute manaha I Rajjusnehen ki tasya tyajatha kunjarottamam II Shlok 3, Sarg 37, Ayodhyakanda'

It means that Ram says-Just I have donated my best elephant, now how can I keep my affection in the rope which was used to tie him? It gives sense that ropes were used to tie the elephant means how much strength was developed in those ropes.

iv) Black thread to wear on west

In ancient days, there was a tradition to wear black thread (multiply) on waist of males called 'Katdora' or Katisutra. It is also mentioned in Ramayan like this

'Shronisutren mahata mechaken susanvruta ।' Shlok 26 Sarg 22 Sundarkand'

Here, Ravan was wearing this 'shonisutra' i.e., black thread on his waist.

v) Hand gloves: Yes, the fighters at that time were used to wear handgloves but they are made by cow leather. Even if Ram and Laxman were also used to wear those. It is mentioned with the word 'Musttavasasam'. Mushta means palm of hand and vasasam means cover or clothing. The original shlok is like this.

'Dirghasibadhagodhasha Sannadha Mrushtvasasam ।' Shlok 19, Sarg 3, Ayodhyakanda'

It is mentioned that the Ram and Laxman were having bigger swords with them and they were wearing handgloves made by cow leather for handling of those swords. Now, we will see one more surprising textile product.

vi) Bandage: Now a days. Bandage industries are there. It is one of the most required textile products in medical field. It was surprising when we found the mention of bandage in poetic sense. It is like this.

'Sandhyrogostitaistamrairanteshwapi cha pandubhini ।
Snigdhairbrapatchaidaibadhavranmivambaram II Shlok 5, Sarg 28, Kishkindhakand'

It means at the time of evening when the sun is setting down the red sky having white clouds over it seeming that like a

white bandage over the wound. The world Vranamivambaram' gives this sense as Vrana means wound and ambar means cloth. Such a way by observing various textile products in Ramayana, we will try to find out the manufacturing hub in it.

D) A land having seiculture:

In Ramayan,Vanarking Sugriv was travelled around the world and he was knowing many more facts related with various parts of the world while given this information he mentions one land like this.

'Bhumicha Koshkaranam, BhumichRajatakaram। Shlok 23, Sarg 40, Kishkindhakand'

It means he was giving information about two lands of silk manufacturer and land of silver manufacturers also. Means, at that time manufacturing of silk through sericulture was routine and there were manufacturing hubs just like Tirpur in Tamilnadu.

2. Conclusion:

After going through the literature of Valmiki Ramayana, we found well developed silk production with other fabrics, also we found with various applications of textiles. It is surprising that many more things, modern fashion like bordering the saree with different colour, a land of sericulture, we got the idea of development of textiles in Ramayana and we came to know about great heritage of textile industry.

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Waste Mapping in Textile Industry

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Abstract:

Wastage is something which should be avoided, but generated due to some inefficiencies in the operation-system. Waste reduction, Effective utilization of resources, Cost- competitiveness and Economic development, are inter-related.

Keywords: *Wastage, Resource Utilization, Textile Industry*

1. Introduction

Wastages arise in the various resources of inputs- the latter in general are identified as, Material, Machinery, Men and Money. Wastages are to be identified and reduced first, and ultimately to be eliminated. The examples and instances given in the write-up are just a few, to illustrate the points discussed.

2. Material and Wastage:

Material wastage may be from Raw Materials, other input direct materials like, Colours and Chemicals (that include, tinting material in Spinning and Sizing Material in Weaving) and packing material. Wastages of raw material are supposed to be part of the final "Good-Output" but results in saleable soft or hard waste in case of yarn, and Sub-standard final output like, "Two parts", "Short Lengths", "Seconds", "Fents", "Rags" and "Chindies" in case of processed fabrics. Discounts given to these "wastes", reduces the sales-realization (called "Value Loss"). Re-processing in "Finishing", "Dyeing"," Mercerizing", sometimes in "Scouring / Bleaching" and even "Usable Waste" in Spinning) is a waste, as it increases the conversion cost.

2.1 Raw Materials

Raw Material forms the single largest component of cost in Textile Mills. Therefore, to monitor Raw Material wastage, many management control systems are in vogue in almost all textile units. Industrial norms based on well-structured industrial surveys by Research Associations (R.As) like, ATIRA, BTRA, SITRA are available. The "Input-Output Reconciliation" in Spinning, Weaving, Processing and Garmenting, is one of the important control system to assess the waste/pilferage. In spinning the input as well as the output is measured in Kg. Correction for moisture will add accuracy of the reconciliation. In Weaving, the input is measured in Kg and the output (fabric) is measured in metre. Care should be taken to use the appropriate conversion for" Number of metres per Kg of yarn". Use of Actual count produced instead of Nominal counts and the fabric specifications like "Picks per inch", "as on table" instead of "as on loom, will add accuracy to the reconciliation exercise. In Processing, the input is metre (for grey-fabrics) and the output is partially metre (for non Fenrs, Rags and Chindies- i.e. FRCs) and Kg for FRCs.There is weight loss of cellulosic component in Scouring/bleaching. Further there is" elongation" and "contraction" (latter during Heat setting, sanforising etc.). All these factors when considered will add accuracy to the reconciliation in Processing.

2.2 Wastage of Utilities

Wastage of utilities like water, steam (thermic-oil-heat), compressed air, power also arise in textile operations. Non-Recovery of heat from use of economizers on boiler chimneys, DG set exhaust, waste steam recovery system, etc. results in higher consumption of the utilities. The machinery audit is required to check the effectiveness of the "Energy Conservation System" installed in the unit.

2.3 Interpretation of the Norms in assessing waste

The norms are to be interpreted after carefully considering all the factors that influence the generation of the direct material waste. These factors are usually identified as, a) the quality of the Raw Material used, b) the quality of the output

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He has exposure to almost all the sections of a textile unit, viz. Spinning, Weaving, Processing, Circular and Warp Knitting, Polyester Melt spinning, Texurising, Embroidery, Garments and Utilities.

His keen interest is in the areas of "Cost Reduction" through effective utilisation of resources in Textiles and Plastic industries.

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required, c) the type of machinery used and d) the skill of the labour deployed. For instance, the cotton waste generated at Blow Room, will depend on the trash content of the cotton fed and larger the trash content, higher the waste. Further, considering the quality of the output- say yarn, the waste extraction at comber and to some extent in card also vary. For instance, to get higher yarn-CSP the extraction of comber-noil will increase. What is important to check is, whether the "noil" extracted is commensurate with the higher CSP required or in the name of getting higher CSP excess "noil" is extracted. Further, if the figure of yarn imperfection (Number of "Thick" minus the number of "Thin") is more, inefficient removal of fiber clusters (or individualization of fibers) at cards is suspected and often flat speed is adjusted to bring out the required result. Higher flat speeds are known to produce higher flat waste. But it is necessary to note that higher waste may be permitted if loss from the higher waste is less than the gain that resulted due to the extraction of higher waste. Similarly, use of "virgin screens" in roller-screen printing, instead of using the "used-screens", may appear to be a wastage but if gains through better selling price and/or the higher quantity sold due to the sharp design obtained on using the virgin screens, is more than the extra cost incurred on using the virgin screen(s), the use of virgin screens is justified. The recovery of Caustic Soda is sometimes abandoned if the cost of steam used is more expensive (often due to high fuel-oil price) and/or when the caustic soda price falls. Therefore, not recovering Caustic soda should not be taken as "wasting" caustic soda.

3. Machinery and Wastage

Machinery remaining idle w.r.t its installed capacity (like, idle machines, idle spindles, unutilized reed space on looms, over capacity of boilers, unutilized buildings/vehicles, excess office equipment like computers, excess furniture etc.) and/or with respect to time, like idle in third shifts or on Sundays/Holidays, etc. falls under the category of wastage. "Cost -Benefit Analysis" for the optimum utilization, is NOT done in some textile units, thus the expensive resource is kept idle... a costly waste.

3.1 The Machinery

The Machinery used (or the technology adopted) also has an impact on the quantity of waste extracted. For instance, the fringe selvedges and tuck-in selvedges used in Shuttle less weaving machines consume more weft. Also, on Super cards the waste extraction is about 1% more than that from the SHP cards. The hard waste in winding differ between auto and conventional machines. Fabric defects-a kind of waste- from conventional looms are more than that from Auto-Shuttle looms and the latter is still more from that of Shuttle-less looms. The "processing-defects" from non-continuous (batch) processing is more than that from continuous processing.

Machine settings are known to impact the wastage. To site a few, in Blow Room, in separation of trash, good lint is also removed and the settings for mote-knives, grid bars, fan speed etc. are critical to reduce the lint loss. In conventional looms, the settings related to slip=pawl or the quadrant in the take-up mechanism and the brake are known to influence the defect like "cracks".

4. Men (Labour) and Wastage: M/c Allocation Vs waste

It is well known in the industry, that excess machine allocation (in an attempt to save labour cost) will be counterproductive. There is awareness that inefficient labour produces more material wastes, defective outputs and even damage the machines. (E.g. bending of front-rollers due to severe lapping on Ring Frame, severe card loading, knife cut – marks on Ring Frame bobbins, winding drums etc.). Inefficiency is often seen in trainee operators," badlies" or whenever a new product is undertaken in Garmenting. The wastage due to labour is mitigated by reducing absenteeism of key personnel like operators, mechanics (& electricians), having training-centers for the trainees to take the place of the key personnel during their absence. Absenteeism level of women-labour is less and therefore, many mills employ women operators wherever and whenever possible (say in Winding, packing and, in day-shifts).

5. Smaller Package, Machine-Stoppages and Waste

The narrow ring dia in Ring Frame, has the potential to produce more doffs and the associated wastage of machine running time. Due to less yarn content on the bobbins from such rings, there is more hard waste in auto-winding, arising from the remnants on the bobbins that fail to unwind. Smaller doffs in looms introduces more stitches to join them and the stitches are known to produce sub-standard fabrics near the stitches, especially in printed fabrics. In Garments also, smaller lays of fabric for cutting, produce more wastages. Uneven yarn length of, a) cones on warping creels, b) beams on sizing creels, and c) the multiple (weaver's) beam at the back of the shuttle-less looms, do create more wastage. In general, it is observed that lesser the stoppage of machines, lesser the defects. Thus, the level of, a) end-breaks in Spinning) warp and weft breaks and shuttle changes in Weaving, c) size of the weaver's beam, d) fabric-doff size on looms, e) lot size (often dictated by marketing requirement on varieties) in Processing –all have an effect on defects (or wastage). Arrangement of "Patterns" in Garmenting, is a specialized job and if done casually, can produce fabric wastages.

6. Fixed length product and wastage

For some products like, saree, dhoti, towel, blankets, head-scarf, hand-kerchief etc., the prices are fixed per piece (of specific length). If the length of the piece is more, there is loss. (For instance, in case of blanket, instead of the standard length of say 1.5m, if 1.55 m is produced there is loss. Similarly, in selling Sewing Thread, the price is fixed per package of some specific weight (say 160gm). If the package contains 165 Gms there is loss. If the length/weights are not meticulously checked, loss results in.

7. Management Policy and Wastage

The Management Policy has a role in, say,

a) Choice of technology/modernization, b) running the plant on all the days in a week and all the shifts in a day, c)

discounts to be offered on non-moving inventory of Finished Goods d) preventive maintenance practices, e) the use of standard consumables and machinery spare parts, f) the practice of machinery audit especially for energy conservation) maintenance of machine break down history to identify and rectify rouge machine or mechanisms or spare parts supplier and so on. Right decisions on all these, will reduce wastage of various kinds listed above.

A unit used to run overtime in its packing dept., every month-end to meet the monthly target and absorb the material in pipe line in packing. On the next day, the packers sit idle as there was no material to pack and take the pay without producing its normal output. Thus wastage may arise due to ill-logical thinking or whimsical fashion of working of the managerial staff- who authorized over-time of these natures.

Infusion of Money and wastage

Money is required to buy various resources. Often, the opportunity cost is considered in deployment of funds. In Financial gearing, the returns generated from the borrowed funds when used in the business, is compared with the fixed interest the fund bear. If the returns are greater than the interest to be paid, the borrowing of funds is advised. The test has to be taken up, every time the interest rate on the borrowed funds changes and/or if the operating profit of the business varies. If borrowing is taken up without any proper thoughtful process, wastage of money (loss) results in.

The purchased resources (Men. Machine, Material) when they remain idle, there is "Wastage "of money. Spoilage on inventory due to improper storage, (rain droppings from the ceiling, water logging on floors etc.) and Failure to take timely action on non-moving stock, are other types of wastage.

9. Tools aiding cost minimization

Various Operation-Research (O.R) tools like EOQ/EBS, JIT, PERT/CPM, L.P., Machine Replacement models, are available to reduce cost or wastage of money.L.P.is a powerful tool used in minimizing Cotton Mixing Cost, maximizing contribution in Sales Product Mix, maximizing advertisement reach for a given budget, and so on.

10. Value Engineering (V.E.) and Waste

V.E. talks of wastage w.r.t. resources consumed for imparting some attributes in a product (or service) for which the consumer does not wish to pay any price. Cheaper substitutes are also considered in V.E exercises.

11. Cost Benefit Analysis

It is imperative to embark on Cost benefit analysis (CBA) when taking decision on, whether loss due to higher wastes is less than the benefit derived from higher wastes. The inference from the CBA changes, when the prices of the various items involved change and therefore, the CBA is to be taken up periodically. (E.g. The net benefit of using Wind Power, Solar power will change when the purchased- power cost changes. In practice, adequate and reliable cost information required and quantification of benefit for the various alternatives considered, are not available and thus objective decision making is vitiated.

12. Conclusion

The above details show that wastage arises in various forms-not just in physical form only. Often textile mills concentrate on wastage of direct material and the idle machinery. Slightly less attention is paid on wastage of indirect materials and non-moving inventory. But the wastage arising from idle, a) labour, b) building (including residential quarters), c) Vehicles, d) Office equipment, e) furniture are often little looked at.

Recently the Ministry of Textiles has called for "Expression Interest" to submit research papers to map wastages in Textile Manufacturing. The topic chosen by the ministry is very relevant for the present day needs, as the suggestions from the research paper are expected to improve the "global cost effectiveness" of the textile units and at the same time save the consumption of the resources paving way to contribute a mite, for the economic development of the country.

Textile Industry in 2024

Vilas V. Gharat

Vilas V. Gharat
Managing Director, Gharat & Associates
Board Member of Trustees, The Textile Association (India) – Mumbai Unit
Mentor of Change, AIM-NITI Aayog. Gov of India.

The Textile Industry in India has been thriving for years, playing a pivotal role in the country's economy and employment generation. As we look ahead to 2024, there are several crucial trends and developments that could shape the industry landscape.

- **Sustainable Manufacturing:** With increasing environmental awareness and consumer demand for eco-friendly products, the textile industry is expected to focus more on sustainable manufacturing practices. This includes the use of organic and recycled materials, water, and energy conservation, and reducing carbon emissions. Government initiatives and industry collaborations are likely to provide incentives and support for sustainable practices.

- **Technological Advancements:** In recent years, there has been a significant investment in technology and automation in the textile sector. This trend is expected to continue in 2024, with a greater emphasis on advanced machinery and digitalization. Automation can improve productivity, reduce costs, and ensure consistent quality. Additionally, emerging technologies like artificial intelligence (AI) and machine learning (ML) may be employed for better production planning, inventory management, and predictive maintenance.

- **Digital Transformation:** The digital revolution has had a profound impact on various industries, and the textile sector is no exception. In the coming years, there will be an increased adoption of e-commerce platforms, digital marketing, and online retailing. This will allow textile companies to reach a larger customer base, offer personalized shopping experiences, and improve supply chain management.

- **Innovation in Materials:** In order to stay competitive and meet evolving consumer preferences, textile manufacturers will continue to innovate in terms of materials and fabrics. This might involve developing functional textiles with properties like moisture-wicking, anti-bacterial, and UV protection. Additionally, there could be an increased focus on sustainable alternatives to traditional materials, such as plant-based or bio-degradable fabrics.

- **Skill Development:** With technological advancements and changing industry dynamics, the textile workforce would require up skilling and reskilling. Training programs and vocational institutes might play a vital role in imparting necessary skills to the workforce. Furthermore, there could be a shift towards a more collaborative and interdisciplinary approach, where professionals from various domains work together to drive innovation and efficiency.

- **Government Support and Policies:** The Indian government has been actively supporting the textile industry through various policies and initiatives. In the coming years, this support is expected to continue and further strengthen. The focus will likely be on improving infrastructure, promoting exports, reducing compliance burden, and providing financial incentives to encourage investments and research and development (R&D) activities.

- **Global Trade and Competition:** The textile industry in India faces both domestic and international competition. With the growing trend of globalization and free trade agreements, Indian textile manufacturers will need to stay competitive in terms of price, quality, and lead time. Strategic collaborations, entering new markets, and maintaining a strong supply chain will be crucial for sustained growth.

These trends indicate that the textile industry in India is poised for significant growth and transformation in the coming years. Despite challenges and uncertainties, the potential for innovation, sustainability, and increased competitiveness makes it an exciting time for the industry. By embracing technological advancements, adopting sustainable practices, nurturing skilled workforce, and leveraging government support, India can further consolidate its position as a global textile hub in 2024 and beyond.

- **Some Key Challenges**

While the Indian textile industry holds significant potential, it also faces several challenges that need to be addressed for sustained growth and competitiveness. Some key challenges are:

- **Global Competition:** The Indian textile industry faces intense competition from other textile manufacturing countries, such as China, Bangladesh, Vietnam, and Indonesia. These countries often have lower labor and production costs, making them more cost-effective for buyers. To remain competitive, the Indian textile industry needs to focus on improving productivity, reducing costs, and enhancing product quality.

- **Infrastructure Bottlenecks:** Inadequate infrastructure, including transportation, logistics, and power supply, poses a challenge for the textile industry. Delays in delivery, higher transportation costs, and frequent power disruptions can impact operational efficiency and overall competitiveness.

- **Skill Gap:** The availability of a skilled workforce is crucial for the growth of the textile industry. However, there is often a disparity between industry requirements and the skills possessed by the available workforce. Bridging the skill gap through vocational training, upgrading educational curricula, and promoting research and development is essential to cater to the evolving needs of the industry.

- **Compliance with Standards and Regulations:** Meeting the stringent quality and safety standards set by importing countries can be a challenge for Indian textile manufacturers. Adhering to environmental regulations and ethical labor practices also requires significant investment in technology and infrastructure. To access international markets and ensure sustainable growth, the industry must comply with global standards.

- **Access to Finance:** Access to affordable finance remains a challenge for small and medium-sized textile enterprises. Limited access to credit and high interest rates can impede investment in modern machinery, technology upgrades, and infrastructure development. Ensuring better access to finance for the textile industry, particularly for small-scale enterprises, can spur growth and innovation.

- **Raw Material Availability:** The availability and cost of raw materials, such as cotton, silk, and synthetic fibers, can fluctuate significantly, impacting the cost of production. Diversifying the sources of raw materials, promoting research in sustainable fibers, and improving agricultural practices can help mitigate these challenges.

- **Complex Tax Regulations:** Historically, the Indian textile industry has faced complex tax structures, including multiple taxes at different levels, which can lead to increased compliance costs and administrative burden. The introduction of the Goods and Services Tax (GST) in 2017 aimed to simplify the tax regime, but streamlining and further simplifying tax regulations would support the growth of the industry.

- **Rising Input Costs:** Fluctuations in the prices of raw materials and energy costs can impact the profitability of textile manufacturers. Volatile input costs can make it challenging to estimate production costs accurately and offer competitive prices in the market. Implementing cost-saving measures, exploring renewable energy options, and hedging against price volatility can help mitigate this challenge.

- **Market Volatility and Uncertainty:** The global textile market is influenced by various factors, including economic fluctuations, political stability, and changing consumer preferences. Uncertainty in demand and market volatility can impact the industry's growth prospects. Businesses need to stay agile, invest in market research, and continually innovate to address changing trends and preferences.

Addressing these challenges requires a collaborative effort from industry stakeholders, policymakers, and institutions. The Indian textile industry needs to focus on improving infrastructure, enhancing productivity, fostering innovation and research, developing a skilled workforce, ensuring access to affordable finance, and creating a favourable business environment to overcome these challenges and maximize its potential.

The Textile Association (India) – Mumbai Unit
Office Bearers for the term 2023-2025

The following Office Bearers of The Textile Association (India) – Mumbai Unit for the term 2023-2025 are elected during their Annual General Meeting held on 26-09-2023.

Mr. Rajiv Ranjan
President

Mr. Rajiv Ranjan is a senior professional and a strategic business leader with 40+ years of multi-domain, crossfunctional experience in the textile industry in India. This includes extensive exposure to a gamut of areas with an overall P&L responsibility of businesses across the tenure.

In his last major industry assignments as Executive Director & CEO at Hindoostan Mills Ltd. (Thackersey Group), Mumbai, and earlier as President (Textiles) at Mafatlal Industries Ltd., Mumbai, he successfully led the businesses by enabling leadership, business and people transformation. He proved his competence in leadership positions in teams in setting up Greenfield Projects & turning around operations while scaling them up into sustainable & profitable businesses.

He is actively associated with The Textile Association (India) – Mumbai Unit as President of TAI Mumbai Unit.

Mr. R. R. Patil
Vice President

Mr. R. R. Patil has been working as CEO and MD with Gokak Textiles Limited for more than 7 years. He is also Whole Time Director with Gokak Power and Energy Limited. He has 42 years of experience in Textiles and Power.

Before joining GTL, he was with Mafatlals at Gujarat.

He has passed B.Text from VJTI, DBM from Welingkar Institute, EXIM from IMC, Mumbai.

He has received Service Memento from The Textile Association (India) in the year 2018 for his Meritorious Services to the Textile Association.

He has been elected unanimously as Vice President with The Textile Association (India), Mumbai Unit.

Mr. C. Bose
President Emeritus

Mr. V. C. Gupte
Chairman

Dr. G. S. Nadiger
Vice Chairman

Mr. A. V. Mantri
Vice Chairman

Mr. Haresh B. Parekh
Hon. Secretary

Mr. Rajiv Mohile
Jt. Hon. Secretary

Mr. Navin P. Agrawal
Jt. Hon. Secretary

Prof. K. D. Gawand
Hon. Treasurer

Dr. Deepa Raisinghani elected as Chairman – JTA Editorial Board

The Textile Association (India) has been framed a new JTA Editorial Board and JTA Advisory Panel for the term 2023-2025 during their Governing Council Meeting held on 24-11-2023 at Hotel Kohinoor Park, Mumbai.

Dr. Deepa Raisinghani
Chairman

Dr. Aadhar Mandot
Hon. Editor

Mr. J. B. Soma
Asso. Editor & Publisher

Prof. Seshadri Ramkumar
Member

Dr. Chet Ram Meena
Member

Dr. Anup Rakshit
Member

Dr. Hireni Mankodi
Member

Prof. R. D. Kale
Member

Dr. Manjunath Burgi
Member

Dr. Bhawana Chanana
Member

Dr. Neha Mehara
Member

Following are the members of **JTA Advisory Panel**;

Dr. V. D. Gotmare
Chairman - TAI

Mr. G. V. Aras
Ex Director – ATE

Mr. Rahul Bhajekar
Texanlab Laboratories

Mr. Rakesh Bali
Reliance Industries Ltd.

Mr. Pankaj Dangra
Rieter India P. Limited

Mr. Subhash Bhargava
Colorant Limited

Mr. Sudipto Mandal
Oerlikon Textile India Ltd

Mr. Hrushikesh Takbhate
Digital & Print Media

Mr. T. L. Patel elected as National President of TAI

The Textile Association (India) has been elected the new Office Bearers for the term 2023-2025 during their Governing Council Meeting held on 24-11-2023 at Hotel Kohinoor Park, Mumbai.

After the fair and transparent procedure from the valid nominations received, Dr. G.S. Nadiger, appointed Returning Officer for conducting the election, has declared Mr. T. L. Patel has been elected as President and Mr. D. K. Singh has been elected as Vice President for the term 2023-2025.

Mr. T. L. Patel
National President

Mr. T. L. Patel is holding D.T.M. and ATA. He is actively associated with the Textile Association (India) – Ahmadabad Unit. He is a Patron Member of TAI Ahmedabad Unit. He has served the TAI Ahmadabad Unit in various positions such as Jt. Hon. Secretary (1985 to 1987), Hon. Secretary (1987 to 1991), Unit President (1995 to 1999) & (2003 to 2019) and Trustee.

Mr. Patel has a wide knowledge and experience of last 35 year of major composite Textile Mills in Ahmedabad and served on various responsible positions.

Mr. Patel became a Governing Council Member for TAI Central during 1983-85, 1995 to 2001, 2003 to 2019, and 2019 to 2023.
Under his dynamic leadership, TAI Ahmadabad Unit's Dinesh Hall Building was re-developed and re-contracted beautifully, which is now a decent Auditorium having capacity of 700 seats.

Unit organized 9 (Nine) All India Textile Conferences in 1951, 1961, 1973, 1978, 1983, 1992, 1998 & 2007, out of which 1992, 1998 & 2007 AITC were organized under his tenure of Hon. Secretary & President ship with a grand success. Under his leadership TAI Ahmadabad Unit was awarded Nine times Best Unit Trophy with 3 consecutive hat-tricks.

Also during his tenure, Unit organized Denim Conference in 1995 & 2010, Cotton Ginning Conference (Back to Glory) in 2013 and 80 years Birth Anniversary of TAI celebrated with Conference in 2019.

Mr. T. L. Patel visited and attended several International and National Exhibitions like ITMA, ITME, ITMA-ASIA, ITMA-ASIA+CITME, GTC and Indonesia for study tour.

He also actively involved and rendered his services for the Social & Chorasi Kadva Patidar Community activities. After rendering his service on the various positions, he is now a member of Trustees of his community.

Mr. T. L. Patel was awarded with Service Memento in 1997 and Service Gold Medal award in 2005 for his meritorious services to the Association. He has also offered his services as Conference Chairman and Advisor for several National and International Conferences organized by TAI.

Shri H. S. Patel, President felicitated to Shri T. L. Patel & his Family members as outstanding contribution, commitments, and dedication in making the new Dinesh Hall during the 76th AGMA of TAI – Ahmedabad Unit held on 28th September, 2023.

He is a Proprietor of his V. K. Associates, Trading business of Textile Chemicals & Auxiliaries and a Trustee of The Textile Association (India) for the term 2023-2027.

Mr. Patel has been uniminiously elected as President of TAI Central for the term 2023-2025

Mr. D. K. Jain
Vice President

Mr. D. K. Singh is a Textile Graduate from The Technological Institute of Textile & Sciences, Bhiwani. He did his B. Tech. in the year 1984. During his long career of 40 years, he has been prominently involved in Synthetic Textile Industry. Presently, he is working as Director of Radici Group, Switzerland and is heading its operations in India. Apart from his contribution to TAI - Delhi, he is also actively associated with the activities of Alumni Association of TIT&S, Bhiwani. Mr. Singh has been associated with TAI - Delhi since 2013. He served as Vice President of TAI – Delhi for the term 2013-15 and President of TAI Delhi for the term 2017-19 & 2019-21. Governing Council Member of The Textile Association (India) for the term 2021-23 & 2023-25. He is also National Vice President of The Textile Association (India) – Central Office for the term 2023-25.

Mr. V. D. Gotmare
Chairman

Dr. Vijay D. Gotmare, passed B.Sc. (Tech.) in 1984, M.Sc. (Tech.) in 1986 and Ph.D. (Tech.) in 1999 all from UDCT, Mumbai. He started his career as Sr. Management Trainee (Tech) in Raymond Woolen Mills, Thane and then as Management Officer (R&D) in Jamshree Textile Mills, Solapur. Then he joined VJTI in 1988 and worked with various capacities such as Senior Scale Lecturer, Associate Professor (PG), Head of the Department of Textile Manufacturing, In-charge Registrar and Associate Professor (PG).

Dr. Gotmare has done various Research projects such as Utilization of textile waste, Ecofriendly textile fibres & processes, High Tech Fibres development for Construction Industries and Medical Textiles, Textile Green Technology,

Functional Finishes, Biotechnology Application in Textiles and some others.
He is a recipient of Hon. FTA of TAI in 2016.

Dr. Gotmare was a former Head of Textile Engineering Dept. of VJTI. Presently he is a Member of JTA Advisory Panel, Representative Director (India) of Frontier Cool Inc., Taiwan

Mr. Mahendrabhai G. Patel
Hon. Gen. Secretary

Mr. Mahendrabhai G. Patel, Lifetime Member of The Textile Association (India) – Ahmadabad Unit Since 2010. He is actively associated with TAI Ahmadabad Unit and became Managing Committee Member in 2012. Then he was elected as Governing Council Member for TAI–Central in 2019. With His sincere hard work, he was promoted as Jt. Hon. Gen. Secretary for the period of 2019-2021.

Mr. Mahendrabhai then elected as Hon. Gen. Secretary for the term 2021-2023, during the G.C. Meeting held at Ahmadabad.

Earlier, he was the owner and run Open End Spinning Mills for more than 15 years. Presently he is doing the business of Import of Spinning Machinery since last 15years.

Mr. A. T. Shahani
Hon. Treasurer

Mr. A. T. Shahani is having Diploma in Textile Technology from M. S. University, Vadodara in the year 1960, securing First Class, worked at Arvind Mills, Ahmedabad as Maintenance in-charge for 12 years in Spinning Department during 1960 to 1972; Bombay Textile Research Association (BTRA), as Senior Textile Technologist for 16 years during 1972 to 1988. He owned consultancy for 2 years.

He also worked at Churchgate group Nigeria for 22 years during 1989 to 2010 as Technical Director and Head of Bombay Office. He introduced the system of Maintenance Audit for the first time in Textile Industry.
In 1972, through BTRA developed BTRA spindle topping apparatus and by using which resulted saving of oil in huge quantity. He had presented about 80 papers on maintenance subject at various conference and published Books on the same subject. He has widely travelled in the world and attended various Textile Exhibitions, Conferences. He has conducted many training programs for Textile Technicians.

He received many awards but the main award is from NRDC, Govt. of India in 1981. He also received Excellent Industrial Contribution award by TAI in the year 2008.

Also Following Members were elected:

Also Following Members were elected:

Mr. K. Gandhiraj
Vice Chairman

Mr. Kamal Mishra
Hon. Jt. Gen. Secretary

Mr. Manjunath Burji
Hon. Jt. Gen. Secretary

Co-opted Members for the term 2023-2025

Dr. G. S. Nadiger
Chairman - PAC

Dr. Deepa Raisinghani

Mr. Hasmukhbhai S. Patel
Hon. Jt. Gen. Secretary

Supported by वस्त्र मंत्रालय MINISTRY OF TEXTILES

61st JTC – Joint Technological Conference
Carbon Fibre Precursor Line dedicated to the Nation

Bombay Textile Research Association (BTRA) hosted and organized 61st JTC – Joint Textile Conference jointly with Ahmedabad Textile Industry's Research Association (ATIRA), Northern India Textile Research Association (NITRA) and South India Textile Research Association (SITRA) during 14th & 15th December, 2023 at BTRA Complex.

During the inaugural function, Dr. T. V. Sreekumar, Director, BTRA, welcomed the Chief Guest Shri Manoj Singh Gaur, Director, IIT, Jammu, Special Guests Smt. Roop Rashi, Textile Commissioner and Shri Rajeev Saxena, Joint Secretary, Ministry of Textiles, Govt. of India; and Shri R. D. Udeshi, President, Polyester Chain, Reliance Industries Limited, Mr. Narendra M. Dalmia, CEO / Director, Strata Geosystems (India) Pvt. Ltd.; Dr. Sharad Saraf, Chairman, Governing Council, BTRA; Mr. Pragnesh Shah, Director, ATIRA; Dr. Prakash Vasudevan, Director, SITRA; Dr. Arindam Basu, Director General, NITRA, Ghaziabad and felicitated with offering floral bouquet and the Memento. During his welcome address, Dr. T V. Sreekumar highlighted the importance of the event as a vehicle of communication to the industry about the latest developments made by four TRAs. Conference, on the day one 14-12-2023, inaugurated with the lightening of the lamp by the worthy hands of Chief Guest of the event Shri Manoj Singh Gaur, Director, IIT, Jammu and other dignitaries presented on the dais.

Smt. Roop Rashi, Textile Commissioner addressing the audience

The dignitaries on the dais present on the occasion

Then Dr. Sharad Saraf, Chairman, Governing Council, BTRA in his Presidential address informed the gathering about the R&D efforts made by all the four TRAs.

Shri Rajeev Saxena, Joint Secretary, Ministry of Textiles, Govt. of India shared their views and briefed on the policy initiatives and developmental projects taken by the union government of India to augment the growth of the textile trade and industry with special reference to technical textiles in India. He also informed the gathering the extension of NTTM upto year 2026.

Smt. Roop Rashi, Textile Commissioner during her address shared her experience and expectation with respect to TRAs R&D efforts and industry connection and the role of TRAs in current scenario and future anticipated technologies.

Shri R. D. Udeshi, President, Polyester Chain, Reliance Industries Limited in his Keynote address mentioned the need of the full-fledged updated testing facilities at all TRAs in view of ever changing technological aspects and supportive role can be played by industry. He also praised the initiatives taken by BTRA for carrying out R&D activities in the field of high-performance fiber and installing Carbon Fibers Precursor Line.

Chief Guest Shri Manoj Singh Gaur, Director, IIT, Jammu in his inaugural address, highlighting the MoU signed between IIT, Jammu and BTRA, emphasized the need of the collaborative works between IITs and TRAs.

At the end of the inaugural function Dr. Arindam Basu, Director General, NITRA, Ghaziabad proposed the vote of thanks.

Thereafter, Chief Guest and other Dignitaries inaugurated Carbon Fiber Precursor state-of-the-art Line, (4000 filament capacity), first of this kind in India, which is installed in BTRA's High Performance Fiber Lab. Also, they all visited the Exhibitor's Stalls and interacted with the exhibitors.

Over the two days, following technical sessions related to various topics were held.

Chief Guest Shri Manoj Singh Gaur, inaugurating Carbon Fiber Precursor Line

Technical Session I - on First Day (14-02-2023)
Topic: GEOSYNTHETICS
Session Chairman: Mr. Nilanjan Sarkar, CTO, Tikitar & Shell India (P) Ltd.

Mr. Lekhaz Devulapalli, BTRA – The Development of Treated Geosynthetics Reinforced Asphalt and Concrete Pavements.
Mr. Shashikant Patil, Chintan Chavd & Deepali Plawat, ATIRA – Significance of European Standard EN45545-2 in Indian Mass Transports.

Session II:
Panel Discussion on "Challenges to Implement QCO and Regulatory Requirements for Geosynthetics and its Impact on Industry" was held which was presided by Dr. Anup Rakshit, Executive Director, Indian Technical Textile Association (ITTA) and following panelist:

Panelists:
Mr. Bidur Kant Jha, Director, Ministry of Road Transport & Highway, Govt. of India
Mr. Himanshu Shukla, Scientist-B, Assistant Director, BIS
Mr. Nilesh Kulkarni, GM, Business Development, Techfab (India)
Mr. Vijay Ramkrishna, Sr. Vice President, Garware Wall Ropes

The panelists shared their thoughts related to following topics
- Awareness on IS Specs. of Geosynthetics, QCO Concepts, and Guidance on Getting Product Certification
- Availability of Specialty Fibers and Yarns in Domestic Markets and Imports for Producing Geosynthetics
- Sharing Experience on Getting Certification on Geosynthetics Products.

Session III: TECHNICAL TEXTILES
Session Chairman – Mr. Narendra Dalmia, Director, Strata Geosynthetics, Mumbai
Ms. Nidhi Sisodia, Mr. A. K. Pandy, & Dr. Arindam Basu, NITRA
- Development of Mulch Mat and Crop Cover Fabrics using Bio-degradable Natural Material: Sunnhemp & Banana Fibers

Dr. Arindam Basu, & Ms. Archana Gangwar, NITRA
- Enhancing Impact Protection in Sports: Optimization of Shear 'Thickening Fluid Application on 3D Knitted Fabrics

Dr. M. S. Parmar, Ms. Nidhi Sisodia, Mr. Swami Sharan, NITRA
- Development of Aluminized Outer Layer of Specialized Firefighter Suit

Technical Session IV on Second Day (15-12-2023)
Topics: CHEMICAL PROCESSING
Session Chairman – Mr. Anjali Prasad, Vice President, South Asia, Textile effect and Management, Archroma
Mr. Prasanta K. Panda, Komal Kukreja, & Amol Thite, BTRA
- Standard Procedure to Identify Dope Dyed and Exhaust Dyed Polyester Fiber

Dr. N. Sudhapriya & Mr. S. Sivakumar, SITRA
- Antioxidant Cosmetotextiles – Durable Nano – Encapsulated Vitamin E Finishes on Textile Fabrics and its Controlled Release Study

Mr. Murtuza Z. Channiwala, Mr. Pankaj Gandhi, & Bhavdeep Shah, MANTRA
- Promotion of Energy Conservation Techniques in Textile Processing Industry: A Case Study of South Gujarat

Ms. Afreen Begum & Dr. Padma S. Vankar, BTRA
- Printing with Natural Dye Lakes Made from RE Salts

Technical Session V
Topics: SPINNING
Session Chairman – Mr. Gurudas Aras, India Advisor, ITA, Germany and Independent Director (Rossari Biotech Group of companies)

Mr. N. K. Nagarajan, SITRA
- Study on Lint Content in Blow Room Lines

Mr. V. Vijayajothi & Mr. N. K. Nagarajan, SITRA
- Effect of Short Fiber Content (SFC) in Raw Material on Lint Shedding Propensity of Conventional and Compact Yarns

Dr. V. Thanabal, SITRA
- A Comparative on the Quality of Airjet and Ring Soun Yarn Made from Cotton

Dr. Amalorpava Mary, SITRA
- Design and Development of Facile High Throughput Needle Less Electro-spinning Set Up

Technical Session VI

Topics: EMERGING AREAS

Session Chairman – Dr. R. R. Deshmukh, Institute of Chemical Technology (ICT), Mumbai

Ms. Shreyasi Nandy, Mr. T. V. Sreekumar, Ms. Shital Palaskar & Dr. Neha Mehra, BTRA
- Plasma Assisted Incorporation of Flame Retardant Chemicals for Improved Flame Retardancy of Polyester Fabrics

Mr. Partha Bairi, Mr. Ankush Sharma & Mr. Tanmoy Gangopadhyay, ATIRA
- Effect of Nanocarbons on the Carbon Fibers – Reinforced Polymer Composite's Properties

Ms. Shital Palaskar, BTRA
- Durable Antistatic Finishing of Polypropylene using Nano Graphene and Plasma Technology

Technical Session VII

Topics: PRODUCT DEVELOPMENT

Session Chairman – Mr. Ullas Nimkar, Chairman, NimkarTech Technical Services

Ms. Neha Kapil, Dr. Arindam Basu, Ms. Priti Kaur Sachdeva & Mahesh Dutta, NITRA
- Development of Natural Fibre Composite for Automotive having Acoustic Properties

Dr. M. S. Parmar, Ms. Shweta Saxena, Mr. Swami Sharan & Mr. Mahadeb Dutta, NITRA
- Study on the Development of Molten Metal Splash – Resistant Jute-Cotton Union Fabrics

Mr. Ankush Sharma, Mr. Partha Bairi, Bhabatosh Biswas & Mr. Tanmoy Gangopadhyay, ATiRA
- Development of Natural Fibre Based Composite Material for Prosthetic Leg Socket

Mr. Amol Thite, BTRA
- A Comprehensive Root Cause analysis of Defects in Textile Materials

Technical Session VIII

Topics: NANO FIBRES AND NANO MATERIALS

Session Chairman – Dr. Neha Mehra, Hod, Textile Department, VJTI, Mumbai

Dr. Chetan R. Mahajan, & Ms. Deepali Plawat, ATIRA
- Free Surface Electro-spun Collagen Nanofibres as Cosmetotextiles

Ms. Smita Deogaonkar Baride, Ms. Padma S. Vankar & Tanushree V. Tandel, BTRA
- Characterization and Antimicrobial Application of Cu and Ag Nanoparticles Coated Fabric

Mr. Murtuza Z. Channiwala, Mr. Paankaj Gandhi & Mr. Bharat Patel, MANTRA
- Biosynthesis, Characterization and Efficiency against Bacteria of Silver and Copper Nano Particles by Nucleation Technique

Mr. Nishant Chandel & Mr. Ankush C. Kanse, BTRA
- Investigation of the Effect of Solvent and Parameters on the Dispersion of Graphene: A Study through MATLAB Simulation

At the end of two days Conference, Dr. T. V. Sreekumar in his vote of thanks expressed sincere thanks to all the Sponsors, Advertisers, Delegates, Office Staff and Press & Media for their support and the cooperation to make this Conference a grand success.

At the end of the conference a National Anthem was performed.

Overall, the 61st JTC – Joint Textile Conference was a memorial grand success event and highly appreciated by the participants from industry/institutes/associations, speakers, sponsors and the industry stalwarts. There were more than 350 delegates attended.

Birla Cellulose Drives Sustainability Agenda in Home Textiles at Karur Hub-Meet

Birla Cellulose, a pioneer in sustainable fiber solutions, hosted a pivotal hub-meet at The Residency in Karur, emphasizing the transformative potential of sustainable Man-Made Cellulosic Fibers (MMCF) in the Home Textiles sector. This meet was attended by 175 prominent exporters and company owners from the Karur cluster, the event aimed to pave the way for sustainable innovation in the industry.

The central theme of the discussions centered on the application of sustainable MMCF solutions in the Home Textiles domain, offering a gateway to eco-friendly, high-quality products that resonate with modern consumer preferences for sustainability. The hub-meet witnessed an active participation from esteemed value chain partners, such as AGT Mills, PKPN, Kumaran, and Ultimax, showcasing a collective commitment to drive sustainable practices across the textile ecosystem.

Distinguished guests such as Mr. K. G. Prithvi, Vice President of Karur Textile Manufacturer Exporters Association and, Mr. S. Gowrisankar, Deputy Director of the Textile Committee in the Karur cluster, along with industry stalwarts like Mr. Perumal, Managing Director of South Indian Textiles, and Mr. Kaliappan, Managing Director of Anboli Fabrics, graced the event.

"Karur's home textile industry welcomes Birla Cellulose's initiative to hand hold them into the adoption of MMCF range. The representatives of Birla Cellulose solved many ambiguities about MMCF which the members had and also provided a much confident purpose to pursue Birla Cellulose's fibres into the regular product offerings as well. The process for incubation has begun and we look forward for more sustainable and economical substitutes for existing raw materials." shared Mr. K. G. Prithvi - Vice President - Karur Textile Manufacturer Exporters Association. Mr. Kaliappan, the Managing Director of Anboli Fabrics added "The elaborate presentation on Birla Cellulose's

product offerings, provided a deep insight into the possible applications of the fibres in home textiles."

The highlight of the session was the profound interest exhibited by exporters in Birla Cellulose's innovative products, prompting a desire to embark on trial initiatives for adoption. Their flagship product Spunshades garnered special attention due to its innovative Color Lock Technology that prevents fabrics from fading even after multiple washes as dye pigments are embedded into the fibre versus conventional fabric piece-dyeing.

"We are delighted and encouraged by the positive response from industry leaders and exporters at the Karur hub-meet. Our deep discussions and eagerness to explore our products reinforce our belief in the transformative power of responsible innovation. Our innovative product Spunshades and other MMCF solutions are poised to redefine the Home Textiles landscape, and the overwhelming interest shown here is truly encouraging," shared Sheerish Kumar, Senior Vice – President, Business Development - Home Textiles of Birla Cellulose.

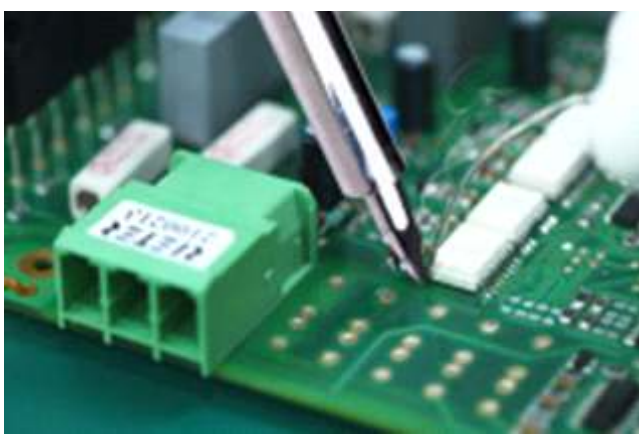
Visit: www.birlacellulose.com

Rieter Opens Repair Services Station in Uzbekistan

Rieter is announcing the opening of its first Repair Services station in Tashkent, Uzbekistan, on December 1, 2023. As the country's most advanced service station, it will enable both faster repair turnaround and minimum production downtime. This will make local customers even more competitive and forms part of Rieter's growth strategy in this highly attractive focus market.

The new Repair Services station in Tashkent complements Rieter's strong presence in Uzbekistan, providing state-of-the-art repairs and sustainable solutions combined with dedicated support to local customers. The station's capabilities cover both mechanical and electronic repairs for all types of Rieter machines, including spinning and winding.

In addition, the repair station has a warehouse where critical parts, such as control units, sensors and drives are stocked to ensure quick turnaround times for repairs. The new service station will operate in collaboration with Textile Service Solutions.



Electronic repairs at the new Repair Services station in Tashkent, Uzbekistan

Rieter's global Repair Services network comprises 25 repair stations in 19 countries, strategically located at the doorstep of Rieter customers.

Each repair station is fully equipped with the testing and calibration equipment required to provide the highest quality repairs. Certified Rieter repair services engineers perform both on-site and inworkshop repairs, using original Rieter repair components and spare parts.

"With the new repair station in Uzbekistan, we are creating sustainable and profitable value for our customers, providing highest quality repairs in the shortest turnaround time, for both spinning and winding machines," says Rico Randegger, Head of Rieter's Business Group After Sales.

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Comprehensive customer service for mechanical and electronic repairs

CII Recognizes NITRA as one of Top 5 Innovative Institutes in India

Confederation of Indian Industries (CII), biggest industry association of India recognized Northern India Textile Research Association (NITRA) on December 15, 2023, as one of the Top 5 Innovative Institutes in India for the year 2023.

NITRA has done and is continually doing lot of R&D and Innovations in the field of technical textiles, unconventional natural fibres and sustainability. It's almost all developments and innovations have been commercialized and benefits are passed on to textile and apparel industry. Innovations are imbibed in NITRA culture.

Right Raw Material, Optimized Production…

The unique Uster combination of quality measurement instruments with sophisticated software is at the heart of an evolution in spinning. FiberQ is the essential starting point to unlocking maximum profits, through absolute raw material consistency. And Uster Quality Expert completes the picture by monitoring quality throughout the production process. By combining these two systems spinners can achieve the full benefits in terms of both quality and profitability.

Uster FiberQ data analysis

Positive feedback from leading mills worldwide confirms the advantages with facts and figures from practical mill experience. Accurate collection and analysis of complex data is applied at every stage, with Uster Quality Expert and 360Q with Fiber Q bringing added value and optimized processing throughout the mill. Stratos Fragkotsinos, Uster's Head of Product Management Mill Management Solutions, explains the importance of Fiber Q and Uster Quality Expert working in harmony to improve the whole mill operation: "Without an optimum raw material management solution it is very difficult and expensive to achieve production of yarn with the right quality and quality consistency," he says.
"On the other hand, even the best raw material solution will not achieve its maximum potential without reliable and consistent in-mill production processes."

The power of software solutions

On the road to Industry 4.0 it's clear that software is an increasingly important driver of progress in quality control. That's especially true in spinning, the most complex of textile segments, with its multiple related process stages. Spinning

firms are also the ones with the greatest need for reliable data collation and analysis if they are to operate profitably. For example, raw material accounts for up to 75% of production costs for spinners, so proper management and minimized waste are essential. It makes sense to partner with the leading expert in data gathering and analysis to optimize this vital element.

Uster's vision was to extend its Think Quality concept across the wider textile community, and a first step was the launch of Quality Expert. A standalone version was launched as a software solution in 2020, with the same features as the system hosted in Uster Tester 6. Uster Quality Expert – now known as UQX – delivers uncompromising standards in ultimate analysis, unique Value Modules and fault prevention mechanisms.

These UQX benefits support optimized settings, minimizing outliers with immediate and reliable notifications. And these optimum setting will have a direct impact on waste levels.
"Continuous in-process monitoring via the value modules of UQX will ensure trouble-free production, since variations in the raw material side are already at a minimum thanks to Fiber Q's efficiency and reliability," says Fragkotsinos.

Mill feedback reports
Quality Expert offers various Value Modules. Yarn Prognosis helped an Indian spinner to solve pilling problems and to restore quality quickly, avoiding losses. UQX enabled analysis of critical issues and guided notable improvements.

One of Pakistan's best-known spinning brands sought the ultimate solution to optimize production routines for assured quality and managed costs. The company's COO is convinced that improving the product quality has automatically improved productivity in the mill. He asserts that, even where cost is regarded as more important than quality, the best way to reduce cost is to improve quality.

Installing UQX proved to be a wise decision for this mill, with its fast and reliable data analysis enabling improvements to processes. It was easier for the mill to identify and prevent quality outliers, as well as troubleshooting machine and component issues – and controlling contamination. The overall verdict was that significant improvements in quality consistency, productivity and profitability were achieved, thanks to analysis by Uster Quality Expert.

It's not only in making 'good' quality 'better' that UQX scores. As evidence, an Indian spinner with yarn quality previously classed as 'average' reports that its quality level is now much higher thanks to Uster Tester 6 with UQX. This mill achieved its dual goal of enhanced market position and higher profitability.
At another spinning mill in India using Fiber Q, UQX was also checking overall production, identifying outliers and enabling setting optimization for every process step. This led to a waste reduction of 2% and a significant improvement in the IPI level (-25%).

Practical proof
It is well proven by practical trials and mill experience that Uster can now boost profitability in spinning mills with FiberQ as the unique raw material management solution in combination with UQX for full in-mill process optimization.

Says Fragkotsinos: "Consistent and optimum input combined with reliable quality monitoring are the key factors for success. It is obvious that together FiberQ from 360Q and UQX can enable maximum profitability for spinning mills."

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Kenya & India - Strategic Partnership!!!

Change the mindset…Devise strategy & Plan roadmap

During my recent visit to Kenya for the ITME Africa & ME 2023 technology & engineering show, I gained a lot of insights about Kenya as the developing textile hub. Through key interaction with the government, local bodies and industry patrons of Kenya, I came to know the industrial scenario of Kenya and was able to manifest a synergy between Kenya's needs and India's offerings. Which I feel must be developed into a strategic relationship.

I would like to narrate that Kenya has a very good potential, resources, a ready domestic market eager for import substitutes, cotton cultivation & a proactive & learning manpower. To succeed they need to just explore the new products coming into their market for technical specifications and most of these products they can easily manufacture in-house with technology advancement from India and technologies yet not manufactured by India can be easily outsourced.

Resources of Kenya:
Kenya has naturally available cotton soil, making it a desirable location for cotton harvest. It has good resource availability for cotton fiber.

Strengths of Kenya:

- Population: Kenya has an 82% literacy rate - The highest in Africa and 70% of its population is under 35 years and is English-speaking. This provides them with a good manpower resource which can be easily trained for acquiring textile skills and utility management for running the units.

- Natural fiber Availability: It has rich cotton-growing soil and

also ready availability of power and adequate water.

- Free Market Entry: Access to International market – AGOA
- Favorable for FDI: Kenya is the 3rd largest economy in sub-Saharan Africa with a GDP of US$ 113.4 Billion and a 5% average annual growth rate
- Well-networked connectivity: It is 2nd in Africa in the Logistics Performance Index having access to regional transport corridors. There are 4 international airports: JKIA is the busiest airport in East Africa. It has 2 seaports and 2 ICDs. Kenya is also labeled as a Green data center. Its capital city Nairobi, is a leading tech innovation hub in Sub-Saharan Africa. 3rd most established startup ecosystem in Africa. The MPesa has enabled Global Money transfer which has 50 Million customers in 7 countries.

Existing Textile Industry of Kenya:
As far as the existing textile industry of Kenya is concerned, there are 65 Textile and Apparel Manufacturers. 7 textile mills out of which 3 mills are running on cotton. 29 units are operating under the Export Processing Zones (EPZ). There are 4 ginneries in operation. Although the numbers are not that huge, Kenya has been the leading Apparel exporter, in sub-Saharan Africa, to the USA under AGOA provisions. This indicates that there is a huge scope for backward integration as the culture of textiles as well as the market reach is readily available in Kenya.

What India can supply

- Textile Machinery & Accessories: All that is needed is the technology advancement. Here I feel seeing Kenya, can build strategic relations with India for technology and skill set development. The existing Indian textile technology and engineering manufacturers can supply the needed machines to Kenya. India can supply the complete setup for ginning, spinning, weaving looms for textiles as well as technical textiles, Processing & printing machinery. It can also be the right partner for knitted garments and woven garment machines.
- Also, financial aid can be taken from the Exim Bank of India which assists in funding for capital good sourcing and has various schemes for overseas projects that export Indian goods. Their "Ubharte Sitaare Programme" not only provides finance but also extends extensive handholding support with technical assistance.
- Cotton: India can also be the right partner for ensuring the quality yield of cotton. A research association from India can assist in testing and harvesting by supplying the right quality of seed and training. Till the harvest is at full peak in Kenya, the balance of Cotton can be made available from India along with comber noil & fine variety
- Woven Technical Textiles: like Canvas Fabric / Tarpaulins and canopies for transportation and buildings
- Tents for camping
- Camouflage fabrics for their military and army
- Agrotextiles for quality cotton harvest and other farming requirement
- Nonwovens for Hospitals & Healthcare like Bleach cotton & disposable products
- Geotextiles, geo bags, acoustic panels, insulation felt etc.
- Rugs, Mattress, nonwoven blankets
- Weaving & Digital Printing - For beautiful African prints at economical cost and scale of operation
- Industrial textiles for a rising manufacturing base
- Supplying recycled fibres to globe from recycled textiles

Conclusion:
For success, it is necessary to have a strategy. And strategy should be very specific with proper research and actual analysis of the country. We, Suvin, as a management consultant can map the strategy that will be specific for Kenya. We can help formulate the short-term goals, long-term goals, mission and vision for Kenya's textile industry. With our experience, we can suggest profiles with investment ratios and profitability indexes for various textile opportunities in Kenya. The probable investor would have to select the right product mix from the profiles created. We can also assist in collaboration and joint ventures with the right partners in India and overseas.

Way forward
- Kenya can strategically partner with India to gain experience not only for developing strong dominance in the spinning segment but also encash on the appropriate machinery manufactured by the Indian players
- Kenya is predominately focusing on their rich culture and colorful apparels. As is seen from the data most of the Kenyan textile mills are closing due to old technology and higher operating costs. India can supply the latest textile engineering technology and take care of skill development in Kenya to revive the Kenyan textile Industry
- Kenya can take advantage of cotton research from India to increase their yield and quality of cotton
- Kenya can look at India as their partner for raw materials for manmade fiber for technical textiles to be produced as import substitute
- Suvin as a management consultant can hand hold Kenya to devise strategy

ITAMMA - Post event report of Seminar

"How to Overcome the Present Situation of Indian Textile Manufacturing & Engineering Industry"

ITAMMA taking forward the Event-Series for the Development of Textile Capital Goods Sector with the support of Ministry of Heavy Industry with Seminar on "How to Overcome the Present Situation of Indian Textile Manufacturing & Engineering Industry" on 16th Dec '2023 at Coimbatore.

Seminar at Coimbatorer on 16th Dec'23

Mr S. Senthilkumar, President (2014/15) ITAMMA informed in his Welcome address that the demand for Artificial Textile Machinery is increasing with a total trade of $887M and at the same time Indian Govt. is also promoting man-made fibres and thus it is an alarm as well as opportunity to Indian Textile Machinery Manufacturers for the development of machines especially for the processing of these fibres. It needs to appreciate that the Textile Machine and Accessories Manufacturing Community has realized the importance of this trend and many had already reacted accordingly.

Mr. Prabu Damodharan, Convener at Indian Texpreneurs Federation ITF), Coimbatore presented in great detail factual data about the performance of the Indian and global textile industry over the past few years with specific focus on how the industry is cyclical and post a great year in 2021 and the drop in 2022, how the signs are clearly visible as to a normalization of the numbers. He also spoke about what textile companies should do in the current situation and make use of the opportunities available currently to grow their businesses.

Mr. Prabu Damodharan, Convener at Indian Texpreneurs Federation ITF), making presentation

Mr. Sanjay Bharadwaj, Sr. VP HR, CGSSC, New Delhi, outlined all the schemes that CGSSC is working with the industry to skill, reskill and upskill the workforce. He spoke about how the industry should work and form clusters to be able to work with Government agencies to improve productivity of their businesses and how CGSSC can help them in this regard.

Mr. Prabu Damodharan, Convener is offered Memento by Mr. S. Senthil Kumar, Past President, ITAMMA

Mr. Sanjay Bharadwaj, Sr. VP HR, CGSSC, New Delhi, is making presentations

Ms Neetii M., Director, M/s Mercury Web spoke about the importance of digital marketing and social media as a tool to grow the reach of businesses and why it is becoming increasingly important to embrace technology.

Ms Neetii M., Director, M/s Mercury Web is offered Memento by Mr. S. Senthil Kumar, Past President, ITAMMA

She also gave information on the quantum of benefits registered by some members after following their presence on Linkedin under her guidance. It was noted worthy to mention about the members extending their reach globally and booking orders from Company at Germany.

Mr. KG. Vishwanath, Managing Director and Global Sales Head, Sambuq "SMART DATA CLINIC – a proposed value-added platform on ITAMMA's Business Enabler Website.

Mr. KG. Vishwanath, Managing Director and Global Sales Head, Sambuq.com making presentations

This session discussed the latest marketing strategies and digital tools that can benefit the capital goods sector. It highlighted how the ITAMMA Business Enabler Platform powered by SAMBUQ offers valuable assets to members and shared future plans for enhancing its role in knowledge and business development for the Textile Engineering and Manufacturing Industries.

Mr. N. D. Mhatre, Director General (Tech), ITAMMA in his presentation gave details of MHI Schemes for the benefit and development of Textile Capital Goods sector. He specifically emphasized on Re-skilling and Up-skilling programmes which can be organized at Coimbatore with the help of CGSSC and other experts under MHI Scheme of Common Engineering Facility Centre" for Textile Machinery which can be further supported by Government scheme -PMKVY-4.0. Mr. Mhatre highlighted the importance of informed industry stakeholders who can collaborate with the Ministry of Heavy Industry to implement policies and schemes that support sector growth.

Mr. N. D. Mhatre, Director General (Tech), ITAMMA making presentations

Mr. P. T. Muralidharan member of Managing Committee delivered Vote of Thanks.

Key take-a ways

CGSSC is keen to work with ITAMMA to provide an API which will enable ITAMMA to bring relevant information about the various schemes of CGSSC.

Seminar underscored the industry's dedication to innovation,

Efficiency and the sustained pursuit of technological excellence through government initiatives. It illuminated the translation of academic research into technological advancements, emphasized the pivotal role of education in shaping a skilled workforce, and highlighted collaborative initiatives that bolster the connections between academia and industry.

The event reinforced ITAMMA's commitment to empowering its members and nurturing industrial growth.

View of Audience

Felicitation of Mr. S. Senthil Kumar, Past President, ITAMMA for taking charge as Hon. 'Treasurer at India ITME Society

LMW and Reliance Spinning Mills Ltd., Nepal - The Partnership Continues

Reliance Spinning Mills Ltd. expands spinning capacity with state-of-the-art LMW smart series preparatory machines for Airjet Spinning project …

Mr. Akshay Golyan, Managing Director

In the global economy, a well-developed ability to create and sustain fruitful partnerships gives companies a significant competitive leg up.

Being a good partner has become a key corporate asset and the partnership between Reliance Spinning Mills Limited, Nepal and LMW for nearly 30 long years is just an affirmative example, which has led to the success and continual expansion of RSML.

Established in the year 1994, RSML is the largest spinning mill in Nepal and is engaged in manufacturing of Cotton, Polyester, Viscose, Acrylic, Blended, Polyester Textured and Special fibre yarns from its two manufacturing units located at Khanar, Sunsari and Duhabi, Sunsari, Nepal.
Nearing three decades of producing high quality yarn, today, RSML's total installed capacity is at 79,824 spindles in 6 nos. Ring spinning units (100% A – Z, LMW Project) and 25 nos. Airjet Spinning machines in 2 nos. Airjet Spinning Unit (100% preparatory machines from LMW), producing nearly 3300+ tons of yarn every month.

RSML & LMW - A continuing association with the Technology leader...
The first unit started in 1994, was established with all LMW machinery. The deliverables offered by the machinery in terms of productivity, quality, user friendliness & easy maintenance, led to lower cost of production and quicker ROI. RSML over the years further expanded with a total of 6 nos. Ring spinning units with 100% LMW machinery totalling 79,824 spindles.

RSML expansion into Airjet segment
After establishing 6 units of Ring spinning plant, RSML planned to expand into the Airjet yarn segment in the year 2021 and have commissioned Unit no.7, with 10 nos. Airjet spinning machines with 100% LMW preparatory machines.

The expansion journey continues … Establishment of Unit 8
As a part of their continual expansion plan, mills planned to increase their Airjet spinning capacity.

RSML – Unit 8 Inauguration

LMW Smart Series machines for Airjet
Mr. Akshay Golyan, "Our association and experience with LMW and its machinery has been excellent. The 7th Unit for Airjet was established with 100% LMW preparatory machines and when we planned to expand with 8th Unit with Airjet for processing P/C (Polyester / Cotton 48/52), our obvious choice of preparatory machines was only LMW. The performance of LMW preparatory machines have made us not to think beyond LMW".

The unit number 8, commissioned recently with 15 nos. Airjet Spinning machines is with LMW smart series machines for preparatory. This state-of-the-art unit was planned to run Polyester / Cotton blend and 100% polyester yarn.

The Gentle Blowroom Line for Cotton is with Automated Bale plucker LA23/S, Varioclean LB9/2, Unimix LB7/4 and Supremoclean LB10/2.

The Gentle Blowroom Line for Polyester is with Automated Bale plucker LA23/S, Unimix LB7/4 and Supremoclean LB10/2.

The Gentle Blowroom Line for Polyester / Cotton Blend is with Mixing Bale Opener (MBO) LB3/6R, Auto blend LA10 (2 chambers) and Unimix LB7/4.

Other machines include Card LC361 – 27 nos., Non-Auto leveller Draw frame LDB3 – 7 nos. Twin Delivery and 4 nos. Single Delivery, Lap former LH 20S – 1 no., Comber LK69 – 4 nos. and Auto leveller Draw frame LDF3 – 10 nos.

Mr. Ashwani Mittal, CEO
"The latest LMW machines are technically advanced and deliver consistent quality at high production rate. Their

automated blending solution Auto blend LA 10 is a technological innovation that helps in accurately blending different materials. Our association with LMW has helped us in our continual expansion due to the state-of-art machinery that delivers quicker ROI".

Mr. Ashwani Mittal, CEO

The material processed is Polyester / Cotton (P/C - 48 / 52) for producing 30s & 40s Ne and 100% Polyester (15s Ne to 30s Ne). The unit produces 19 Tonne/day of quality yarn. The machines are so versatile, that they are capable of handling any material with ease at higher productivity and ensuring consistent quality.

LMW Gentle Blowroom is so versatile to process various materials and with the state-of-the-art Auto blend LA10 machinery, different materials can be blended up to a ratio of 99:1 at a blending accuracy level of +/- 1%. Auto blend LA10 is with a maximum of 4 feeders @ 500 kg/hr per feeder and Two-line output is possible with two different blends %. Load cells are used for direct measurement of Min. 100 gms to Max. 3000 gms per drop. An online weight variation monitor is provided which monitors weight & stops the machine if there is a weight variation. This automation solution helps in accurate blending of material and helps in manpower reduction.

The Blowroom Line is designed with the flexibility to process different materials. The machine comes with different options of opening elements which are required to ensure effective handling of fibres. The material is fed to card with continuous feeding system to maintain constant feeding.

Card LC 361/363 with the highest active carding area with 36 working flats ensures effective fibre individualisation. The card has a pressure-regulated chute for uniform feed to card. The licker-in zone has a pair of arcual combing segments which helps in better opening and removal of fused fibres in licker-in zone. Linear can changer gives increased machine efficiency.

The breaker Draw frame LDB 3 with single and twin delivery (independent drive arrangement) enables the machine to perform at highest efficiency. The machine has lifetime lubricated top roller end bush which reduces machine downtime. The programmable oscillating TR strip coupled with inverter-controlled fan motor ensures a clean working environment. The higher delivery speed is achieved with a unique drafting system with shorter travelling length of sliver to coiler.

The finisher Draw frame LDF3 S with precise servo-driven operation and mechanically synchronized drive system enables impressive speeds of up to 1100 m/min. The Duo Digital Levelling Principle sets new standards for sliver quality. The pneumatically aided SP - Smart Auto Piecing System eliminates manual piecing. The centralized roller setting arrangement with a single tool ensures enhanced user-friendliness and maintenance convenience. The Lap former LH20 S and Comber LK69 are a perfect combination for unmatched production and quality of combed sliver.

"The LMW Smart Series machines provide the most suitable solutions for Airjet Preparatory process, for classical as well as the blended process ".

Mr. Ashwani Mittal, CEO, "Today the requirements of end users are changing rapidly. To cater to the requirements of our clients, we require machines that are robust and offers high productivity and quality. LMW machines are equipped with the latest technology and offers us high productivity, consistent quality, power savings and raw material savings. The machines are highly user friendly and maintenance friendly".

On the future of Textile Industry and RSML's growth plans, "The textile industry is cyclical, and we have been witnessing many short cycles off late. However, the long-term growth story stays intact, and the future looks quite promising. We at RSML will continue to expand to serve the industry and our association with LMW will continue in all our future projects", Mr. Akshay Golyan.

SaXcell and Birla Cellulose sign Memorandum of Understanding for recycled fiber

SaXcell and Birla Cellulose sign Memorandum of Understanding for recycled fiber production to accelerate circularity.

Textile recycling innovator SaXcell has signed a Memorandum of Understanding (MoU) with Aditya Birla Group's, Birla Cellulose, one of the world's largest manufacturers of man-made cellulosic fiber.

The MoU paves the way for the expansion of collaboration between the two companies for production of recycled man-made cellulosic fibers. SaXcell's textile waste pulping technology combined with Birla's advanced wet spinning expertise results in high-quality sustainable "SaXcell" recycled fibers serving the circular textile needs of customers at commercial scale.

Commenting on the development, Mr Erik van der Weerd, CEO, SaXcell, highlighted that this collaboration fits SaXcell's vision to set up a robust circular textile supply chain based on partnership and mutual commitment. He explains, "To address today's social and environmental challenges of the textile industry, global collaboration is imperative. We need to facilitate a change from a linear to a circular economy and we need to do it now. SaXcell's and Birla's combined innovation force and production power offer a great opportunity to create real impact."
Commenting on this circularity and sustainability focussed collaboration, Dr. Aspi Patel, Chief Technology Officer, Aditya Birla Group and Birla Cellulose, points out, "Birla Cellulose is strongly committed to support innovators for expanding circular fiber offerings in the textile and non-woven value chain. We have been exploring innovative business models and partnerships, this collaboration is one such initiative, where we aim to help SaXcell leapfrog from pilot to commercial demonstration scale. Such partnerships will play an increasingly important role in accelerating circularity in global textile value chain."

SaXcell B.V. is an innovative technology development company that recycles used textiles into feedstock for

making new and sustainable man-made cellulosic fibers. Creating the new fibers requires less water, land and chemicals. A team of researchers from Saxion University of Applied Science in Enschede started with SaXcell B.V. in 2015. After extensively testing and improving the technology, a pilot factory was successfully built in 2020. By 2024 SaXcell will further expand by building a Small Scale Production plant in Enschede, The Netherlands.

Birla Cellulose, the pulp and fibre business of the Aditya Birla Group, is a leading sustainability-focused Man-Made Cellulosic Fibres (MMCF) producer.
Birla Cellulose operates 12 sites for pulp and fibre manufacturing that apply environmentally efficient processes including recycled materials, closed loop technologies contributing to enhanced conservation of natural resources. Birla Cellulose is among the top Hot Button Ranking MMCF producers and has been accorded a 'dark green shirt' by the Canopy Planet Society. Its five global advanced research centres are equipped with state-of-the-art facilities and pilot plants. Birla Cellulose's fibers are made from renewable wood and are produced using processes with lower environmental impact.

Birla Cellulose collaborates actively with its upstream and downstream partners to create a bigger and broader positive impact on the sustainability of its value chain.

Z-Wire - Outstanding web forming at high speeds

Speed is exciting – but it can be challenging too. In nonwovens production, for example, hydroentangling lines can hit production speeds of up to 300 m/min at the winder. That creates difficulties for carding and web forming. Now, innovators at Trützschler Card Clothing have created the solution to this high-speed problem. It's called Z-Wire…

Every company in every industry is constantly pushing for more efficiency and productivity. For nonwoven textile producers, that means high-speed production lines that achieve excellent quality within a faster timeframe. Trützschler's Z-Wire clothing for worker, stripper and doffer rollers empowers our customers to move forward with their ambitions for speed, efficiency and quality.

It has serrated contours to make sure fibers are continuously held in position, even at high production speeds. The fibers

Z-Wire Nonwovens wire

are then released at exactly the right moment to be transferred and orientated.

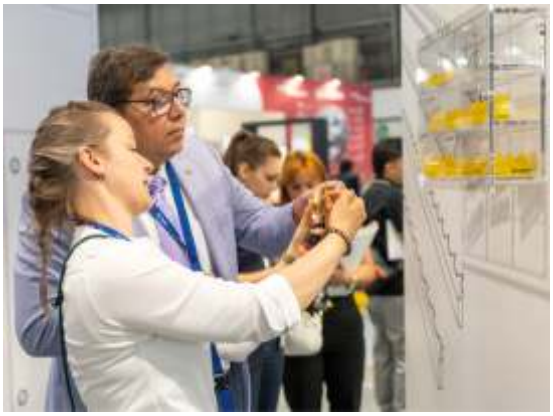
This controlled transfer from roll to roll enables uniform web formation, while fiber fly is minimized, the risk of fiber migration is reduced and the operational reliability of the line increases.

These advantages make the Z-Wire the perfect fit for Trützschler Nonwoven´s NCT. The optimized interaction between machine and clothing enables maximum performance from highspeed cards. As a result, the Z-Wire is now successfully established on the market worldwide.

Feedback from our customers

Our customer TWE has shared direct feedback about how the Z-Wire performs in real-world production situations. TWE was founded in 1912 and is a proven specialist in innovative nonwovens solutions worldwide. The company processes a wide range of fibers such as viscose, polyester and polypropylene in fineness of 1.7 – 17 dtex. It has an annual fiber throughput of 1.85 million kilograms. TWE uses the Trützschler Z-Wire at its site in Emsdetten, Germany.

"We use the ZDAB2 wire for worker and stripper rollers on several plants – and we are completely satisfied," says TWE Head of Production Andreas Wolbring. "We achieve higher production speeds compared to the standard wires. The worker rollers, for example, operate at a production speed of 200 m/min. There is also less contamination because there are no grooves on the sides. Since we started using Z-wires, our production has become much more efficient."



ITMA 23-Tag 2 37

Andreas Wolbring, Head of Production TWE

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