Proceedings of
online
National Conference on Fashion Apparel and Textile
(NCFAT'20)

theme

"Fashion & Textile Industry 4.0 – Opportunities & Challenges for Education 4.0"

14th October 2020 | Amity University, Uttar Pradesh

Organized by
AMITY SCHOOL OF FASHION TECHNOLOGY
Amity Directorate of Applied Arts/Fine Arts/Performing Arts/ Visual Arts
Amity University Uttar Pradesh
Noida-201313 (U.P) India

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Message from Vice Chancellor

Prof. (Dr.) Balvinder Shukla
Professor – Entrepreneurship & Leadership and IT
Vice Chancellor, Amity University Uttar Pradesh
Patron – NCFAT 2020

I am pleased to learn that **Amity School of Fashion Technology** under Amity Directorate of Applied Arts/Fine Arts/Performing Arts/Visual Arts, Amity University, Uttar Pradesh is organizing online "**National Conference on Fashion, Apparel & Textile (NCFAT'20)" on the theme "Fashion & Textile Industry 4.0 – Opportunities & Challenges for Education 4.0"** on **14th October 2020**.

The current worldwide scenario due to COVID-19 pandemic has caused huge reforms in the policies and procedures of organisations globally. Amity has also brought tremendous shift in the functioning of the university and taken several initiatives with the support of latest technology to ensure uninterrupted services to all stakeholders, continued learning, education, research, etc., NCFAT'20 is one of such initiatives which is being organised virtually to deliberate on Fashion, Apparel and Textile Industry expectations from professional education in the field and to bring together academicians, researchers and experts for facilitating, interacting and exchanging ideas for the same.

Fashion Apparel and Textile Industry is one of the key sectors of the Indian economy. Innovation in this sector does not only depend on product innovation, but the new digital technologies applied to design and production processes are increasingly becoming crucial. Education 4.0 can substantially redefine the way in which designers and companies work and respond to the changing needs of the market and consumers, in line with the requirements of Industry 4.0. Education must unleash the true potential of a student by recognizing and actualizing it. Industry 4.0 has a significant potential to change whole manufacturing processes and business models for labor intensive textile and apparel industry. Skill development & entrepreneurship development are key requirements for success of this industry.

In this context, I am sure that NCFAT'20 would greatly benefit all the participating researchers, academicians, young professionals &students associated with Fashion, Apparel & Textile field.

My Heartiest Congratulations to the organizing team for organizing this conference on an important topic of academic interest and industry relevance.

I wish **NCFAT 2020** a grand success!

Prof. (Dr.) Balvinder Shukla

Conference Chairperson's Message

Prof. (Dr.) Pradeep Joshi
Director General
(Amity Directorate of Applied Arts/Fine Arts/Performing Arts/Visual Arts)
&
Dean (Faculty of Applied Arts/Fine Arts/Performing Arts/Visual Arts)
&
Director (ASFT, ASFA & ASPA)
&
Conference Chair

It gives me immense pleasure to welcome you all to online **"National Conference on Fashion, Apparel & Textile 2020 (NCFAT'20)"** *(theme : **"Fashion & Textile Industry 4.0 – Opportunities & Challenges for Education 4.0")*** being organized by **Amity School of Fashion Technology under Amity Directorate of Applied Arts/Fine Arts/Performing Arts/Visual Arts, Amity University, UP.**

NCFAT'20 proposes to deliberate on recent developments and trends in Fashion, Textile & Apparel industry with focus on Industry 4.0. It will also discuss approach towards Sustainable future and Perspective on Innovations in Fashion & Textiles. Deliberations on Opportunities & Challenges for Education 4.0 is one of key objectives of conference. Broad Area being addressed in conference include Perspectives on Fashion and Textile Education, Challenges and Opportunities for Textile and Apparel Industry, Innovation in Fashion and Textiles, Entrepreneurship Development for Fashion and Textiles, Sustainability to Fast Fashion and Textiles, Fashion and Digital Technologies, Skill Development for Apparel Industry, Fashion Marketing and Communications, Influence of Visual Merchandising on Consumer, Fashion Marketing and Merchandising, Artificial Intelligence in Fashion and Textiles and Recent Advancements in Home Textiles.

The Fashion, textiles and apparel industry in India has strengths across the entire value chain from fiber, yarn, fabric to apparel. It is highly diversified with a wide range of segments ranging from products of traditional handloom, handicrafts, wool and silk products to the organized textile industry. Fashion, Textile and apparel contributes 4% of Indian GDP and constitutes 15% of country's export earnings. It is highest net foreign exchange earner for the country and provide employment opportunities to large number of manpower. India with natural advantage in raw material (cotton, silk, cellulosic fiber) and easy availability of skilled labour, strong base of varied traditional design, color and embroidery combination provide key advantage to Indian textile & apparel Industry. Textile and apparel sector is the most dynamic manufacturing

sector where eternal demand for change keeps fashion alive. In today's competitive world; innovation is the key to sustain and grow. E-commerce is changing the whole equation of fashion retail in era of covid-19 along with dynamic challenges of Industry 4.0. There is definite need to integrate feedback of all stakeholders for designing programme structure and course curriculum of various professional programmes being offered by educational institutes to make students industry ready which will contribute in growth of industry.

NCFAT'20 aims to bring together academicians, industry experts & researchers in the field of fashion, apparel and textile for facilitating deliberation in form of paper and poster presentation. I take this opportunity to thank all invited delegates, distinguished Academicians, Industry Leaders Researchers & faculty colleagues who are associated with **NCFAT'20** and making this reality.

I wish **NCFAT'20** a great success.

Prof. (Dr.) Pradeep Joshi

Brief Profile of Invited Speakers

1. Mr. Ram Sareen, Chairman and Founder, Tukatech

For half a century, Mr. Ram Sareen has served the garment industry with an extensive history characterized by one word: disruptive. This philosophy is ingrained in Tukatech, the fashion technology solutions company Mr. Sareen founded in 1995.

Tukatech is credited with successfully bringing digital pattern making to dozens of countries and are an innovative leader in virtual sample making for design and fit with real-time motion simulation. They were the first to develop and implement on-demand manufacturing processes and are known for advanced cutting room solutions. Tukatech's robust systems are implemented by fashion experts from all corners of the garment industry.

2. Mr. Vijay Mathur, Executive Director in Apparel Training and Design Center

He has over 42 years of experience in the Fashion & textile industry is Currently Executive Director in Apparel Training and Design Center, managing 138 Training Centers and 10000 Training. Former Additional Secretary General AEPC, looking after garment exports of $ 17 billion; policy making in Commerce, finance, labor issues. He was the Former Chairman of Glocal Skill Management Pvt Ltd New Delhi; managing skill Assessment in Apparel skill space. Former Sales Manager in Maharashtra State Textile Corporation. Former Assistant Manager in National Textile Corporation. Worked in Glaxo Labs Ltd; JK Tyres.

3. Dr. Rajesh Bheda, Managing Director of Rajesh Bheda Consulting

He is a leading consultant, researcher and educator with over three decades of contribution to apparel industry. He is known for his celebrated book 'Managing Productivity in the Apparel Industry' and inspiring supply-chain collaboration for win-win performance improvement. He is consultant to International Trade Centre-Geneva, International Labour Organisation, EBRD, CBI-Netherlands, Asian Productivity Organisation-Japan and several Govt. bodies. His organisation, Rajesh Bheda Consulting has emerged as a trusted partner of international brands, apparel manufacturers, industry associations and development agencies. Over 480 organisations in India and overseas including Myanmar have benefitted from the consulting and training services of RBC. Before forming RBC, he was Professor and Chairperson of Fashion Technology Department at the National Institute of Fashion Technology. Dr. Bheda holds a Doctorate in Management from the Faculty of Management Studies, University of Delhi and has undergone fellowship at the Manchester Metropolitan University UK.

4. Mr. Kazi Iftequer Hossain, President, Bangladesh Garment Buying House Association

He is born and brought up in Bangladesh experienced in the garments Trade for 37 years in home and abroad. Working in international companies 'M/S Shah Safari'/ 'Pepe Jeans' and proline as a garments brand retailers and trading house. He has got an experience with brand like Slazenger / Kangol. His extensive work expertise covered total value chain of sourcing to shipment of merchandise. Working closely with brands and interprets to local manufacturer. His working with eco-friendly product for the save of planet. He is involved with the organization as a President of 'Bangladesh Garments Buying House Association' which

is a one of the largest association in Bangladesh for readymade garments. 'Mr. Kazi Iftaquer Hossain' obtains Graduation in Commerce from Victoria Government collage under the University of Chittagong. He was participating every year in Textile fairs abroad for machineries as well as textile. He has been Travelling abroad for gathering knowledge of new technology.

5. Dr. Rajkishore Nayak, RMIT University, Vietnam

Dr. Rajkishore Nayak is working as a Senior Lecturer with the School of Communication and Design (SCD) at RMIT University, Vietnam. He completed PhD from the School of Fashion and Textiles, RMIT University, Australia and has also worked there for 3 yrs in teaching and research. He also served as Product Development Engineer at Bruck Textiles, Australia from 2012 to 2013. Dr Nayak worked as a Senior Lecturer in TIT&S, Bhiwani (Fashion & Textiles), from August 2004 to August 2008 and as Project Associate at IIT, New Delhi, for 2 yrs. His teaching interest includes sustainable fashion and textiles, circular economy in fashion, advanced manufacturing technology in fashion and textiles; and research interests includes circular economy, sustainable fashion and textiles, human ecology, advanced materials in fashion and textiles. He has published about 120 peer-reviewed papers in national and international journals and 11 books in fashion and textiles. Dr. Nayak has been conferred with several prestigious awards like RMIT Excellence Awards for Learning and Teaching in 2019, RMIT University Team Award for research excellence in 2015, RMIT Research and teaching Award in 2012, and RMIT University International Scholarship in 2008. Dr Nayak has witnessed a long and successful professional journey in academics, research and industry. Dr Nayak has several funded research projects to his credit like Tontine Group-RMIT University funded project on flame retardant textiles; Stab and spike protection projects from DMTC, Australia; Firefighter's protective clothing, RMIT University funded project, and AICTE and Govt. of India, New Delhi funded project on comfort and handle properties of fabrics produced from Khadi, Handloom and Mill sectors".

6. Ms. Anupama Singal, Fashion & Tech Entrepreneur / Co-Founder SLICeR, Singapore

Ms. Anupama helps fashion companies 'See Beyond' tabular data, making better decisions, driving profitability & productivity. It Often referred to as a 'Fashion & Tech Girl", Anupama is known for breaking stereotypes. With an Engineering degree from IIT Delhi and Fashion Marketing Diploma from NIFT Delhi, she pursues both the streams of fashion and technology with equal zest. She worked at Levi Strauss for 14 years, leading several Transformation Projects across Asia Pacific in the areas of Product Offering, Business Intelligence, SAP deployments, and demand Forecasting and Planning. She left Levi's to jump into entrepreneurship.

As a Co-Founder at 3 companies, a speaker and an author, her vision is to touch a million lives meaningfully. As the Co-founder at SLICeR, she has built an innovative merchandising & data analytics platform called Kanvas that helps fashion companies see beyond their data, and improve profitability & productivity.

7. Mr. Venky Nagan, Group CEO of Asmara International Ltd, Hong Kong

A progressive company in the domain of global-sourcing & exports of fashion apparel. Asmara has design, merchandising and production offices in the Far East, South Asia, MENA region and Barcelona. Mr. Venky completed his B.E (Hons) Mechanical Engineering from BITS Pilani followed by an MBA from the IIM, Kolkata. Asmara Group serves fashion brands like Zara, Bershka, Abercrombie & Fitch, Hollister, R.E.I, Urban Outfitters, Ann Taylor, Tom Tailor, Marc O' Polo, Groupe Dynamite and others. Their value added

services include 3D - Designing & Fitting; Digital monitoring of production and quality, Research & Development on Sustainable Materials and Processes.

8. Mr. Anupam Biswas, AVP- Design Edhardy and Flying Machine at Arvind Limited

He has a Creative Work experience of 17yrs, Supervised direction of overall strategic vision, shaped and guided creative paths. Responsible for the design, art direction and management of all the product lines. Worked closely with agency leadership to defining brand DNA, communication and all creative arts. Expertise in inventing powerful integrated selling ideas and re-strategizing brands/ labels for India's most prestigious retailers and brand houses.

9. Dr. Surinder Tandon, CText FTI, MNZM, Tandon Textile Innovations, New Zealand

A New Zealand citizen, is an international Textile Consultant (Process and Product Innovation & Commercialisation) after serving as Senior Scientist in Textile Group at WRONZ /AgResearch Ltd, Lincoln, New Zealand, where he had worked for 27 years. He has B.Tech (Hons) from TIT Bhiwani, M.Tech from IIT Delhi and PhD from Leeds University. He has worked on R&D and technology transfer for commercialisation with a number of textile companies, research organisations and educational institutions worldwide. He is Member of the International Council of the Textile Institute (UK) • Fellow of the Textile Institute (UK) • Chairman of The Textile Institute (NZ Section). He had been awarded • Institute Medal at the 88th Textile Institute World Conference in Malaysia in May 2012 • He is Winner of the Inaugural International Product Innovation &Commercialisation Award, the Textile Institute (UK), World Conference, Hong Kong, 2008 • Member of the Textile Institute (New Zealand Section) since 1990. • Member of the New Zealand Order of Merit), Queen's Birthday Honours, June 2014, for services to textile industry and community. • Paul Harris Fellow (Rotary International)

10. Ms. Pami Kular, GROUP Head of Sustainability, Continuous Improvement at CIEL Textile, Mauritius

3 decades of International experience in Europe, Estonia (USSR), India, Pakistan, Bangladesh, USA, Madagascar and Mauritius across Manufacturing, Retail & Hospitality environments, underpins Ms. Pami Kular's decision to drive another area of uncharted territory- Ethics and Sustainability. She has been responsible to define and consistently operationalise across the group, a strategy to be Sustainable and Ethical in their operations and interactions with all stakeholders within the sphere of business. Her role involves building internal management infrastructure with a team of sustainability and environmental technicians to deliver on the highest sustainability standards in the diverse and respective environments. She has played an instrumental role in adoption and implementation of Sustainable Apparel Coalition's (SAC) Higg-Index suite of tools to measure and establish transparency in the journey towards sustainable product design and production with full commitment to Zero Discharge of Hazardous Chemicals (ZDHC).

11. Mr. Anand Bhushan, Fashion Designer

He is an award winning post graduate from the National Institute of Design, Ahmedabad and a graduate from the National Institute of Fashion Technology, New Delhi, but more than his formal education informs his training and experience as a designer. An understanding of where fashion and textile has been and where it may be going is vital to Anand's technique and to his creative process. This understanding mingling with Anand's design sensibility and desire to create something different from the league makes him one of the most celebrated designer of the Indian Fashion fraternity.

The label “Anand Bhushan” makes fashion creative but also able and continues to cultivate the modern, edgy take on upscale dressing which the designer has become known for. His garments always reflect a sense of novelty and innovation, presenting out of the box designs for the fashion lovers. Mingling contemporary western silhouettes with the Indian crafts and techniques keeping his distinct approach, Anand is excelled in creating the ensembles which entire world takes notice of with appreciation and reverence.

The designer places a lot of emphasis on the process, by truly displaying an understanding of the process and lifecycle of a garment from the textile to the end use. The sensibilities of the brand are edgy and the style is one that caters to customers for upscale dressing.

12. Mr. Pratyush Nawani, Director, Technical Consulting, Excel Global, Bangalore

Mr. Pratyush Nawani is a very Senior Apparel, Accessories, SLG, footwear and Soft Lines SOURCING Professional. He is a seasoned traveler who has worked as an expatriate in many of the global manufacturing countries over the years like India, Sri Lanka, Bangladesh, Nepal, Vietnam & Indonesia. As a team Leader, with, more than 25 Years of experience, he has worked with brands like, Calvin Klein, Tommy Hilfiger, Van Heusen, Izod, Arrow, GH Bass, HUGO BOSS, Prada, The North Face, ARMANI, GAS, Guess, BENETTON, Liz Claiborne, DKNY, j Crew, GAP, Levi's & Dockers, H&M, Ralph Lauren etc. to name a few. His strengths are process and operations management, sourcing, total quality management, supplier certification and social accountability compliance, 6-sigma, Garment Manufacturing, Washing/Dyeing- Dry and Wet Processes. Fabric and Garment Testing protocols and Job enrichment Training. He has worked with reputed apparel companies like Triburg, ITC, Shahi Exports, Hollit International, PVH Corp. His last assignment was as Director of Quality assurance at Newtimes Group taking care of the quality of all merchandise sourced out of Vietnam and Cambodia worth approximately 320 million dollars. He is now working as Director, Technical Consulting with Excel Global.

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Perspectives on Fashion and Textile Education

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ABSTRACT

The ever-changing scenario of the Fashion industry has a direct impact on the academics of fashion. While the industry adapts, adopts and advocates change in every sphere whether it be in tech applications, sustainable practices, textile innovations or disruptions in retail formats, it is imperative that these changes, as they evolve, are addressed in the classroom, and it is only logical that the origin of these innovative ideas are generated in the classrooms first.

As sayings go, Necessity is the mother of invention, or the only constant about change is change itself, fashion educators need to be the torch bearers who are stepping steadily in the direction of bringing about that much required shift in the pedagogical framework. Under the mantle of teaching age old crafts and techniques as a way of ensuring posterity of the arts, one often tend to ignore the urgent need to contemporise the curricula to make learners more equipped to take on the industry as it evolves, with its volatility and frequently changing landscape.

This paper intends to revisit the current curricula and methodology of teaching and learning in an institution that imparts knowledge of Fashion and Textiles and attempt to suggest various innovations in pedagogy that can be adopted while revising topics, juggling classroom and outdoor experiential learning and introducing practices that are relevant to the changing environment of the fashion and textile industry.

Keywords: Pedagogy, Revised Practices, Textile innovation, Fashion, Sustainability

1. INTRODUCTION

As an academician over the last five years the constant challenge has been to make each lecture more engaging and more informative than the previous one. Curriculum outlines are well defined by schools across the globe and while some stringent guidelines are to be followed with set deliveries, there is often room for improvisation and application of individual skill by the teacher. It is this little window of opportunity that allows creative expression and at times helps build that bond between the teacher and the classroom full of eager minds ready to absorb. Involvement of teachers in shaping curricula based on their daily experiences in the classroom and outside is bound to result in dynamic lesson plans that are relevant to what the student needs, ultimately making them ready for a workplace that's demanding innovation in every sphere.

Just like the fashion industry, a world that's defined by change, re-inventing itself to provide for an audience that is hungry to satisfy various needs ranging from providing a basic necessity or help define ones personality through the sartorial medium to serving specific purposes such as occasions and other activities like functional clothing for active sports and fitness, armed forces and other departments requiring uniforms to catering to clientele with special needs. It is imperative to be relevant in every step along the process of development, from fiber to consumer, encompassing each process, viz: yarn, weave, processing, garment development, market placement, display, purchase and maintenance and the repurposing wherever possible and all of which are induced with technology in one or multiple ways, we at design schools need to adapt to this metamorphosing landscape.

With the number of design aspirants emanating in such large numbers, from Design Schools how does the industry make a choice, what are the parameters that influence the hiring of talent from one school v/s another, all of them being of substantial repute.

Thus, it is imperative for each school to build a distinct and unique individuality that makes it stand apart. Bridging a special gap, fulfilling a specific need of the industry. This is achieved by development of a distinct

designed curriculum in conjunction with what employers need.

2. CURRENT EDUCATION SCENARIO

Most design schools usually begin with a foundation process which are mainly generic and helps open the mind in a creative sphere, where everyday objects, activities and surrounding get a visual uplift with heightened aesthetic perspectives.

This can be an overwhelming experience. Do we need to measure carefully the inputs we provide, should we take it up a few notches in the direction of a specific stream and utilise the foundation year to provide them with a dual pronged approach in equal measure? It is debatable.

A well-defined pathway study consists of

a) Generic Foundation

b) Stream specific learning is a way forward where a generic foundation process puts colour, form and shape amongst other topics into design perspective.

A stream specific foundation curriculum combines classroom and industry learning by taking the student out into the workplace and vice versa and then teaches by example at the onset and not just in the later years of learning.

Traditionally, it is viewed as a gradual learning process and a strong foundation sets perspective right in the mind of a learner. What is the current pace that the new generation of learners are equipped to learn at? It is definitely quicker than millennials or premillennial generations. The ability to grasp, absorb and retain is at a new level today, more than ever.

To reiterate my idea an article in Forbes magazine states that

*a) "Young people are building new power dynamics, in what the researchers call a "**highly experimental and constantly evolving...new power beta."***

***b) Youth are approaching power in new ways**, wielding it collectively through social media and new vectors of influence.*

*c) Communication is no longer largely top-down, wielded by a relatively few, oligarchic gatekeepers. Rather, it's as likely to be a **peer-to-peer massively parallel conversation**."*

By interpreting the above excerpts I intend to talk about a time today when the hierarchy between teacher and student is transforming into a more equal space where there is sufficient acquisition and sharing of knowledge keeping in mind that through new ways of information dispersal, we as teachers may skip information that is available on platforms we may not necessarily patronise. We must be open to this shift in equations and adapt willingly. We must acknowledge that the limits of receptive ability are new, experimental and more heightened.

Textiles, Crafts and the Study of Eras and Arts in relation to costume are crucial to any Fashion curriculum. Currently they span the history, evolution, advancement and in some cases sustenance of the practice. While this is important to teach these subjects because it has shaped where each of these subjects are today in their practice or in legacy.

It isn't enough though, to talk about these topics in isolation. For e.g. talking about the history of brocades, where it hailed from, its process and its hierarchical allocation or the bustle, the crinoline or the pannier and its construction detailing, isn't enough. It is necessary to refer to the highpoints of these and other aspects that influence garment history but contemporise these techniques, with due respect to their origins but making it relevant for today.

How can a weaver learn from todays learner how to alter the current way on which fabric is woven, to achieve the essence of an age-old fabric like a damask with much lesser consumption of yarns thus making it more economical?

Can the traditional embroidery of Lucknow, Chikankari be blended with a technique like intricate hand-woven Venetian Burano lace patterning to create a new product all together by introducing a study of its similarities.

Taking reference from Dior's New Look, how can it be likened to and made more relevant by talking about designers today who have been applying these silhouettes to their current collections.

Subtraction cutting by Julian Roberts or 3D pattern making and sewing by Shingo Sato or contemporary styles of Kallol Datta are often taught as modules, can they be included in curriculum books today?

Artificial Intelligence, UI and UX are buzz words that have taken over every sphere of society and influencing human and robotic interface immensely. What are these topics all about? Measurement Apps and body scanning screens have made their way into departmental stores, have they been installed in our Pattern Labs, well just a few or almost none. Similarly the most advanced CAD machines today come at a hefty price, can these manufacturers offer it to design schools such as ours at affordable prices to include in the labs, this along with sufficient subsidy from the government on specialised technology like these to include as part of our curriculum that will make learning more interesting. State of the art Knitting machines and software for efficient assembly line planning are just a few amongst the hordes of other advancements available.

Popular OTT platform Netflix has to its bouquet an array of content relevant to accompany classroom academia. *Explained: At leisure* talks about technology in garments that maps the on and off field/pitch time of a sportsperson, a device that was earlier a wristwatch or an accessory that was relied on for this kind of information.

We may frown upon the use of a phone in the classroom, but if it can be used to make relevant exemplar reference to content available online or through App searching platforms it may be a boon rather than bane. Can we possibly encourage technologically driven outcomes such as app design and development, as deliverables rather than just clothing that looks pretty but lack impact of current relevance?

Are some practices that are considered secondary research viz: data collected online, become primary in an era where "*devices such as Amazon Alexa, Apple Siri, Google Home, and Microsoft Cortana. Using conversational interfaces, fashion brands can gather data by asking customers questions, understanding customer desires and trends, diving deeper into their purchase patterns and suggesting related and add-on items."* We can bring these devices to the classroom and include these practices as part of learning for Fashion design, styling and merchandising curricula.

We could include field trips to the offices of tech giants, production units that rely heavily on technology for data analysis, system generated product performance from the shop floor and to manufacture the product itself. All of which require an early initiation and development of the students mind to think beyond fathomable boundaries.

My endeavour is to take a step back and look at various other methods

3. SURVEY REPORTS

To emphasize on the need for change, I engaged with other academicians on their perspectives on the current scenario and I have listed below.

Ms. Rugmani V. Faculty and a current PHD researcher says "*Currently a lot of curricula is very polytechnical in approach and not exploratory. Some basics and more of exploration have to be covered. Often, subjects are not integrated, so kids are clueless on the outcome Technology and software technology need to be introduced, along with soft skills as all are extremely relevant There need to be elective workshops every semester At NIFT they have an option of GP (Graduation Project) and DC (Design Collection). All colleges need to provide that."*

Ms. Meher Castellino A well-known and respected personality in the industry and a board member as advisor to many colleges in India, is of the opinion that it is *imperative to facilitate change in the way we impart learning*, but at the same time she said *"The faculty needs to be upgraded along with the students."*

Ms. Swikriti Rajpal: Faculty agrees and says "*Absolutely, but at the same time I feel everyone is racing to meet the global changes but I feel we need to understand the Indian market, and what is available here. It needs to be practically applicable to most importantly the market they are in. Domestic market needs to be taken equally seriously as the global market."*

Ms. Kali Rawat: Draping and Design Faculty also agrees with a view that "*It's too much of spoon feeding in India; independent thinking is not encouraged, and silhouettes are not original. Especially smart textiles and latest innovations in fabrics need to be included."*

Ms. Sabbah Sharma: Faculty, Designer and Stylist, "*Teaching styles vary, going by some Indian practices*

we are stuck with old methods of teaching, especially in design. Design in currently taught to build a student's skill, but what the future holds for us is the need for creativity along with the skill. Skills of PMGC (Pattern making and Garment construction) is good but it will be taken over by technology."

In comparison of Indian and Italian styles of teaching she says…. *"in Italy they gave us skills but the focus was on providing for a need and conceptualisation and less on the technical aspects of getting a pattern or stitching correct. All of which will be mechanised, technology will get more affordable. I may be able to feed in data to a machine of my idea and this machine will provide a ready garment.*

I think education needs to reach the aspect of building strong concepts. We need to step away from trends. Sustainability in a context of multiple uses of a garment increasing its lifespan. Trend is an oxymoron to what sustainability is. To focus on utility, expression of conceptualisation should be focused on. Students today learn to make pretty garments, but that's not enough. We have all we need to take it to the next level.

While understanding technology it is also equally important to see where human race is headed, individual expressions in a larger space. Breaking away from stereotypes and typecasts of body shapes, inclusivity, standards of beauty and style. Methods are dated but bring new meaning to our traditional crafts. Honestly, it's the fashion people who demean fashion itself by making it frivolous. But it is upto us to present it as it really is, serious business."

4. CONCLUSION

At the root of knowledge is the school that initiates students into the world of Fashion. This inculcation is the main starting point. Fashion and Textile education must be inclusive and should encompass learning on various levels. It should also teach sustainability – educating the next generation on the benefits Mother Nature has provided us, and how we can weave that environment consciousness into the curriculum. Also, about the various indigenous arts and crafts and the ideology that go behind the making of a textile and the textile language. India has many sari weaves that in a manner of speaking, vary every 100 kms or so, and this the fabric of society. This is the story that needs to be understood by students and faculty – the idea that in our history and the varied geography is the cultural symbolism of each area. The diversity of fashion language is in seeing oneself and expressing it to all.

Thus, fashion and textile education is a vital link towards preserving the historical and the cultural narrative of the land. The next generation is more city-based and may not have access to the elders to tell the story, and hence narratives are needed to persevere, inculcate, inform and disseminate information.

The progress of a nation is how it preserves its culture. And fashion and textile design is a language culture that needs preserving with current relevance. And urgently.

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The Role of Emerging Technologies in Fashion and Textile Education

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ABSTRACT

India has a huge young population which is inside educational institutions. India is going through a phase of quick, fluid, long lasting, influential changes in the areas of fashion and education. The major factors contributing to this change are a young population that has taken advantage of improved telecommunication facilities, smart phones and Social Media Apps. A very significant percentage of the population is doing business through digital means. Today's students are going to be tomorrow's business leaders and consumers. Under such circumstances, educational institutions, including fashion institutions, have been changing to some extent, according to current times. Digital transformation (DX) is developing at a very fast pace and is in a very fluid state. Today we are witness to the huge impact of Digital Transformation (DX) on people and its contribution to the fashion industry. As the current situation is very fluid and developing at a very fast pace, this would be the right time to discuss on the future direction that education should take to cater to future needs.

The fast growth and user friendliness of Emerging Technologies like Block chain, Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) are influencing the buying habits of a young generation in a short period of time. The ramifications of such developments are going to be far reaching and influencing. Such developments should be understood and discussed to choose the right kind of information and knowledge to be imparted to youngsters.

Keywords: Fashion, Education, Smartphone's, Social Media

1. INTRODUCTION

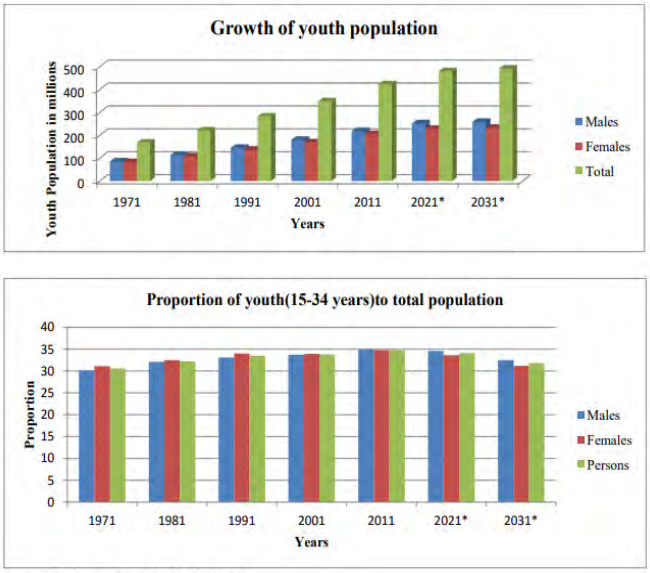
India is one of the countries in the world as of today having a very young population. Most of these youngsters are studying in educational institutions. India is also going through a phase of influential changes in the areas of Fashion and Education. Contributing to these changes are the significant number of youngsters using improved telecommunication facilities, smart phones and Social Media Apps. Digital Business is done by a significant percentage of the population. The youngsters who are involved with such businesses are going to be Business leaders and consumers. Under these circumstances Educational Institutions especially fashion education is going through major changes according to the times. On the other hand Digital Transformation (DX) is developing at a fast pace. Digital Transformation is also in a huge manner impacting the Fashion Industry and consumers. So under these circumstances this would be the right time to discuss on the future direction to pursue as far as education is concerned to cater to upcoming needs in the future.

2. PAPER OBJECTIVE

The paper aims to discuss the importance of youngsters, fashion education and emerging technologies, in India. recent developments that are taking place for the past few years at a very fast pace in the telecommunication industry. Which direction to take so that a significant number of young students study relevant technology to cater to future needs.

3. INDIA'S YOUNG POPULATION

According to statistics released by Government of India the youth population (people in the age group of 15-34 years) is 421959000 out of which 333365000 are in the age group of 15-29 years (Youth as defined in National youth Policy 2014). The projections for the years 2021 and 2031 are as follows according to Fig 1:



Source: Registrar General of India (RGI)

Fig. 1.

4. TELECOMMUNICATION FACILITIES

India has emerged as the fastest growing telecom market in the world. The tele density was just 1.4 per cent in 1995. By December 2010 it rose 60 percent. In big cities like Delhi, Mumbai, Kolkata and Bengaluru, it has gone up by 130% to 140%, much the same as in Europe and North America. India's telecommunication network is the second largest in the world by number of telephone users (both fixed and mobile phone) with 1.183 billion subscribers as on 31 May 2019. India has one of the lowest call tariffs in the world enabled by mega telecom operators and hyper-competition among them. As on 31 July 2018, India has the world's second-largest Internet user-base with 460.24 million broadband internet subscribers in the country.

5. DIGITAL TRANSFORMATION (DX)

Digital Transformation (DT or DX) is the use of new, fast and frequently changing digital technology to solve problems. One of the examples of digital transformation is cloud computing. It reduces reliance on user owned hardware and increases reliance on subscription based cloud services. Some of these digital solutions enable - in addition to efficiency via automation - new types of innovation and creativity, rather than simply enhance and support traditional methods. Here it should be noted that Fashion Industry is a very creative industry which would adapt to such technologies very quickly.

One aspect of digital transformation is the concept of 'going paperless' or reaching a 'digital business maturity' affecting both individual businesses and whole segments of society.

Digital transformation is already underway. According to the McKinsey Global Institute's 2016 Industry Digitization Index, Europe is currently operating at 12% of its digital potential, while the United States is operating at 18%. Within Europe, Germany operates at 10% of its digital potential, while the United Kingdom is almost on par with the United States at 17%. This shows that Digital Transformation (DX) is an evolving phenomenon and growth is inevitable. On the other hand according to the Harvard Business Review the digital backbone of the world's second-most-populous country and largest democracy, namely India, has continued to develop. When compared with the status quo even five years ago, their view is that India is leapfrogging into the Fourth Industrial Revolution, with the government still at the center of that transformation.

6. SMART PHONES

Smartphones are a class of mobile phones and of multi-purpose mobile computing devices. They are distinguished from feature phones by their stronger hardware capabilities and extensive mobile operating systems, which facilitate wider software, internet (including web browsing over mobile broadband), and multimedia functionality (including music, video, cameras, and gaming), alongside core phone functions such as voice calls and text messaging.

As of 31 December 2018, India had a population of 130 crore people (1.3 billion), 123 crore (1.23 billion) Aadhaar digital biometric identity cards, 121 crore (1.21 billion) mobile phones, 44.6 crore (446 million) smart phones, 56 crore (560 million or 43% of total population) internet users up from 481 million people (35% of the country's total population) in December 2017, and 51 per cent growth in e-commerce.

7. SOCIAL MEDIA

Social media are interactive computer-mediated technologies that facilitate the creation or sharing of information, ideas, career interests and other forms of expression via virtual communities and networks. The variety of stand-alone and built-in social media services currently available are wide ranging; however, there are some common features like: a) Social media are interactive Web 2.0 Internet-based applications. b) User-generated content, such as text posts or comments, digital photos or videos, and data generated through all online interactions, is the lifeblood of social media. c) Users create service-specific profiles and identities for the website or app that are designed and maintained by the social media organization. d) Social media facilitate the development of online social networks by connecting a user's profile with those of other individuals or groups. Some of the most popular social media websites, with over100 million registered users, include Facebook (and its associated Facebook Messenger), YouTube, WeChat, Instagram, QQ, Qzone, Weibo, Twitter, Tumblr, Telegram, Baidu Tieba, LinkedIn, WhatsApp, LINE, Snapchat, Pinterest, Viber, VK, Reddit, and more. Social media can help to improve an individual's sense of connectedness with real or online communities and can be an effective communication or more importantly marketing tool for corporations, entrepreneurs, non-profit organizations, etc.

8. FASHION AND EDUCATION

In short Fashion can be defined as a popular aesthetic expression at a certain time and in a certain context, especially in clothing, footwear, lifestyle, accessories, makeup, hairstyle and body proportions. Today though Fashion Education includes various departments like Accessory Design, Fashion Communication Design, Design Space, etc., Textiles form the basis of most of these businesses and are an integral part of the fashion industry! So, updating the methods of training using the latest technologies and innovations is very important to cater to the fashion industry. This kind of education has already been practiced in NIFT, the pioneer institution as far as Fashion studies are concerned. Vandana Narang, Campus Director, NIFT, Delhi said in an interview dated 2016, about faculty members for the first ten years being sent abroad for training, and the support that came both from the government of India as well as a project of the United Nations Development Programme (UNDP). She said, “It all started with that one course (on fashion design) in 1986. Today, we have seven Bachelor's programmes and three Master's programmes. We have had five PhDs in the last two years from NIFT Delhi, and two from outside. This clearly shows the requirement of qualified professionals in India. Today because of the tremendous growth in the telecom sector and the increase of users of various state of the art technologies, this is the right and high time to introduce courses or subjects that would benefit the industries and customers of the future. Let us at this juncture take a look at technologies that are fast emerging and attracting the attention of people in general and youngsters or students at large.

9. EMERGING TECHNOLOGIES THAT MAY BE BENEFICIAL TO STUDENTS IN THE FUTURE

Blockchain: The demand for trust and security from both consumers and enterprises alike has led to the creation of Blockchain, the next inevitable step in the global progress towards redefining the new-age internet. Blockchain can be implemented across diverse sectors, and one such sector that can benefit the most from it is shipping. According to the World Economic Forum, Blockchain has the potential to improve communication and border administration which could generate an additional $1 trillion in global trade. It should be noted here that India is an exporter of Fashion goods in large quantities!

Artificial Intelligence: As consumers, where do we feel it is absolute necessary for human interaction with AI? A survey done by Ericsson Consumer Lab states that 73 percent of consumers would prefer AI as search engines for computers / mobile devices. Sixty four percent believe that AI would make great travel guides, while 57 percent prefer them as personal assistants. In the lower 40th percentile is AI as teachers, medical advisors, and financial advisors. Japan is a great example of consumer AI. In preparation for 2020 Olympics, the country has developed robots to assist travelers in their daily tasks. Personal robots are already available in Japan to assist their owners. It might not take a long time for such personal robots to enter fashion showrooms!

Augmented Reality / Mixed Reality: Traditional marketing methods such as poster campaigns, TV advertising, video clips, etc. are becoming crowded. Immersive technologies such as AR/ MR have the potential to break through those barriers by grabbing a person’s attention, and giving them an immersive and

personalised experience. In healthcare, AR / MR is being applied in the pre-operative planning phase of surgeries. Medical professionals can plan their entire surgical process using 3D holograms that can accurately depict spaces for incisions and also allow for envisioning the consequences of their moves. Compared to the medical profession, fashion industry can without doubt use the accuracy of such technology.

Virtual Reality: Fully-immersive environments and surreal experiences are just some of the ways that VR is going to change the way we live, work, and play. But how are businesses and developers leveraging the power of VR to deliver fully immersive experiences? For example, retailers are looking to take the engagement of online shopping to the next level by using VR to engage the audience when it comes to buying a product. By accessing a virtual online shop, through a VR headset, consumers can interact with the item they would like to purchase. This technology seems to be tailor made for the highly creative side of the fashion industry which can make use of the limitlessness of this technology!

10. ANALYSIS

From the above-mentioned facts, it is clear that the pioneers of Fashion Education in India previously envisioned well ahead of time to cater to the needs of the future. Today looking at the information mentioned above it is very clear that we are at a juncture where a lot of developments are in progress which might rule the world sooner or later. So, it will be suitable to prepare students and youngsters to face these realities in the near future.

11. CONCLUSION

It is evident that a lot of choices are available to the young generation to use. The key is which technology is going to be chosen and how it is to be used. It is high time Fashion and Textile education should, without doubt incorporate latest and emerging technologies to develop students and youngsters to be suitable to handle the future of the industry.

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Perspectives on Fashion and Textile Education: Evolving Methods of Practical and Self Learning

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ABSTRACT

The gap between virtual & real world is reducing significantly and technological advancements are reaching the consumers at breakneck speed. The learning environment is required to be more integrated with technological innovations both at the product creation side as well as consumer end. The consumer & designer both are constantly reacting to the changing times and this will in the end completely alter the traditional fashion cycles, business practices and methods. In a long term 4-year degree, it will be a challenge for curriculum to be relevant at its culmination. This creates an opportunity for a floating and integrated blended learning environment with seamless experiential learning both inside & outside of the classroom. The curriculum must be more adaptable to quick changes. The current Covid-19 pandemic situation & New education policy 2020 will further accelerate, the teaching learning approach towards Online Education blended seamlessly with offline experiential learning.

Keywords: Blended Learning, Sustainability, Experiential Learning, Virtual Learning Systems

1. INTRODUCTION

Virtual Reality is pacing up at a great speed in today's era, with the advancement of appreciating technology. The digital identities have differentiated from physical identities. The old methods are slowly being replaced by the new technology. In manufacturing, digital prototyping is deleting layers of design & production process, allowing us to reimagine, how we create and sell products (Unknown, 2020). Businesses started to be aligned to this change in order to achieve sustainable growth and development. Online retailer Yoox has launched a feature in its app where shoppers can create, style and share a personalized digital avatar by taking a selfie. In autumn 2020, Tommy Hilfiger will launch a collection designed and developed using 3D technology, with products modeled on virtual avatars. By spring 2022 all of the brand's collections will be designed in 3D (Unknown, 2020). This brings in the need for a holistic outlook of theoretical understanding and practical approach to go hand in hand irrespective of the nature of the business. The creators, designers and innovators are discovering the new ways to achieve amalgamation of these key futuristic trends. There is a need of looking at design as a whole and not just from the perspective of product or process.

2. AIM TO SUSTAINABLE DEVELOPMENT

With the increased consumer awareness all over the world about environmental & social implications of the Fashion industry the consumer has started giving importance to sustainability. The businesses are increasingly focusing on a more conscious approach of design and communicating with the consumer. With this emerges the understanding of social concepts, minimalist lifestyle, disruptive choices of the products they consume, its legacy and history. The mindset of use and throw is being replaced by use and reuse to co-exist. The pandemic global shutdown has accelerated these future trends, what was expected to change in a decade may change much sooner. Global shut down has created need for micro communities for survival & evolution. As 2022 approaches, expect to see more brands safeguard their relevance through stores with local or targeted curations, designed to connect with specific customer groups at a local level. An example of this is H&M's small-format store in Berlin's Mitte Garten showcases local brands and partnerships as well as tailoring and recycling services, plus a curated edit of its own product. H&M says half its future sales will be via digital commerce, so stores like this will likely play a bigger role in its brick and mortar strategy, moving forward (Unkown, 2020).

3. CIRCULAR VS LINEAR: SERVICE & PRODUCT

In the industry any company will always provide a service along with a product. A retailer or a brand will give alterations, exchange or returns service. A manufacturer will give design or sample development service. These services mostly end up using more resources in a linear business model. Paving the way to create businesses that focus on 'improved capacity utilization and less resource waste'. "The design of such business models can be done on at least five different levels", as illustrated in the below figure (Jørgensen, S. a. P. L., 2018). For example, 'MUD Jeans' not just produces, but offer lease and repair services, launched in 2013; they can reuse either parts of or all of the products and resell them to refurbish and renew products instead of extracting new, virgin resources (Jørgensen, S. a. P. L., 2018). Another example is Cambodia-based 'Tonle' that uses surplus fabric from mass clothing manufacturers to create zero-waste fashion collections. Using more than 97 percent of the material that it receives and turning the rest into paper. These exemplify the concept of up cycling & circular production process over the more traditional down cycling. (Jørgensen, S. a. P. L., 2018)

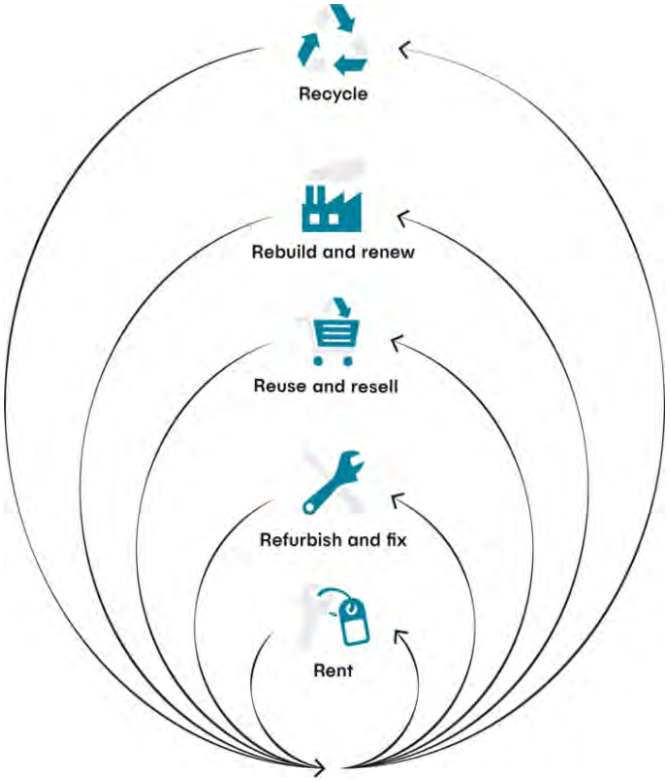

Fig. 1.

4. CONCLUSION

This draws a conclusion that the current fashion studies following the footsteps of the industry there will be a need for disruptive approach, flipped classroom, problem based learning, design thinking, competency based methods and research intensive approach. The designers of the future will not just design an image, product or function but also services that go along. Cost escalation due to sustainable practices can then be balanced with increased capacity utilization. This is an area where the current curricula do not focus and may render students at the end of the 4 year education, not adequately ready for the industry's needs. They need to have an ability to design for a world that lives virtually as much as physically, when garbage is a resource and technology is omnipresent.

The students will require more time and space for self-learning, experiential study, extensive use of technology and media, free-flowing blended learning accessible anywhere at any point of time through virtual apps like Web based Classroom, Virtual Boards, Learning Chat Rooms, Continuous Feedback and finally a learning, that spur an innovative mindset to appropriately survive in the future. This will evolve them as the responsible doers & evolutionary creators.

The teaching pedagogy needs to be extensively based on innovative blended teaching methods evolved inside and outside the classroom and supported with both Online and Offline Tools.

Fig. 2. New-age design teaching methods

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Effect of Visual Merchandising Display on Consumer Buying Behavior towards Intimate Apparel

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ABSTRACT

Visual merchandising plays a major role in bringing consumer inside the retail store or to visit the website page. visual merchandising is increasingly being used in-store and on web to enhance the shopping experience for buyers and expand a brand's reach. The study is aimed at identifying the impact of visual merchandising on the buying behavior of the consumers towards inner wear. Present research includes both the online and offline visual merchandise displays that influence the consumer attention and their buying behavior towards intimate apparel. To execute the planned research a survey will be conducted using purposive sampling method in conjunction with snowball technique. A sample of fifty female consumers from the city of Meerut will be selected for the study. A pre tested questionnaire and interview will be used to procure the data regarding the preference towards intimate wear based on the merchandise strategy followed by the retailers and online stores.

1. INTRODUCTION

The purpose of this qualitative research is to find out the impact of visual merchandising on the purchasing behavior of female consumers towards intimate apparels. The retail industry is expanding day by day so it is very important for retailers to differentiate themselves from the competitors. For that they have to update themselves with unique storefronts merchandise display, product mix and store environment. The intimate apparels has been considered as a personal issue and the purchase intention is entirely dependent on the various functional consideration and amount of wear ability. If we compare intimate apparels with other fashion clothing the perception of consumer towards intimate apparel is entirely based on functional aspects. Consumer generally focus on physical consideration of intimate apparel such as functional support. The main focus of this paper is to contemplate and analyze the relation between visual merchandising strategies and their effect on consumer buying behavior towards intimate apparel. Many past researches states that consumer shopping is highly influenced by visual merchandising display. The way merchandise are promoted and displayed on the store can have a major impact on consumer buying behavior. In this study visual merchandising elements are categorized in two sections, interior and exterior displays for analysis and conclusion. Interior elements include display elements like music, lightning, color, mannequins, cleanliness, props, interior signs, space and layout, creative display, focal points, fragrance & video display. Exterior elements are entrance window display, exterior signs, brand name etc.

2. STATEMENT OF THE PROBLEM

For brick and mortar retailers it is very important to understand to stay in business about different techniques which differentiate themselves from their competitors. window display of intimate apparel

Product nature: In contrast with other outerwear, intimate apparel is treated as a personal issue. respondents states that it is not expected to be seen in public. It is an embarrassing and unspeakable topic in public. Once intimate apparel is seen by others, the wearer becomes psychologically uncomfortable.

3. PURPOSE OF THE STUDY

Main focus of the study is to identify the impact of visual merchandising techniques on consumer in intimate apparel segment. The study also investigate the effect of exterior visual merchandising and interior store atmosphere on the purchasing behavior of female consumers toward intimate apparels. Visual display of storefront windows is a important factor to attracting customers inside the store, another factor that effect the consumer shopping behavior is the interior display of merchandise and ambience of store. The appropriate use

of aesthetics develop a positive or negative atmospheric environment inside the consumer mind, which directly influence the consumers buying decisions.

4. DESIGN/ METHODOLOGY/ APPROACH

Explorative research was deemed most appropriate for this study and qualitative data was collected. A sample of fifty women between the ages of 25-40 of Meerut city was selected. Primary data was collected by a questionnaire which include general information like gender and age. And to find out the impact of visual merchandising elements on buying decision a likert scale is used to identify level of impact from strongly agree to strongly disagree. The result of questionnaire help merchandise planner and retail industry specialist to better understand the impact of visual merchandising on consumer decision process for intimate apparel.

First, primary data were analyzed to find out, whether visual merchandising elements have an impact on the population. Primary data were analyzed using charts. to find out the Primary data, a total of 50 samples was analyzed, age group wise clusters were taken to see which age group has a greater influence over visual merchandising elements.

Collected data showed that there were few female consumers who disagreed with the fact that visual merchandising has impact on their purchasing behavior toward intimate apparel. It clearly shows that the few visual merchandising elements have a less impact towards consumer buying behavior. From the collected data, it was found that merchandise display on mannequin and store front make them feel uncomfortable and have less impact on consumer on the other hand colour combinations, lighting, and creative display also has influence consumer to buy the product.

5. QUESTIONNAIRE FOR CUSTOMERS

Two types of data sources were selected as primary and secondary data. For primary data collection fifty walk-in customers were picked, to fill the questionnaire.

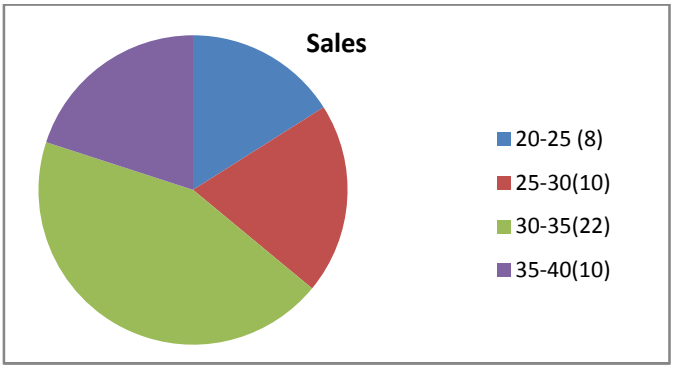
6. RESULT AND DISCUSSION

Total response

Response of consumer were analyzed to see the effect of visual merchandising elements on consumers buying behavior. Below graph indicate that 72% of the total respondents are agree that visual display elements effect their shopping behavior.

76% consumer states that they less prefer to buy their intimate apparels from traditional store as sometimes they feel uncomfortable due to the presence of male retailers also because of the display of the product as well as they also agree with the fact that they feel uncomfortable in telling their preference related to any particular style or design to the retailer as most of time retailers are also unaware about any particular style. women state that they hardly do any kind of experiment related to size and color with their lingerie.

Age group information



7. RESULT OF CONSUMER QUESTIONNAIRE ANALYSIS

Technique	Strongly Agree	Agree	Neutral	Disagree	Strangely Disagree
Merchandise display	0	36	6	8	0
Window display	0	8	25	17	0
mannequins	0	5	20	25	0
Colour combination	3	42	5	0	0
lightning	12	38	0	0	0
Exterior and interior signs	20	30	0	0	0
Layout and space	18	32	0	0	0

Technique	Strongly Agree	Agree	Neutral	Disagree	Strangely Disagree
Video display	0	38	12	0	0
Online shopping	38	8	4	0	0
Taste and preference	0	12	8	22	8

CONCLUSION

According to the result of the study, it is clear that visual merchandise of intimate apparel has a moderate impact on purchasing behavior of female consumer as most of female consumers don't like use of mannequins for the display of lingerie. 60% women agree that they didn't get the product according to their preference because of limited availability of merchandise o retail store. India is a very conservative market and women feel uneasy while doing purchasing for their intimate apparel this is because in most of traditional retail stores salesperson are male and women feel uneasy with question of retailers about their size and choice also the traditional stores have limited shelf space and they stock very common and few sizes and styles. And most of retailers have limited knowledge about lingerie products. On the other hand e-retailing provide a judgment free atmosphere to purchase the product also e-retailing provide greater variety of lingerie products in terms of style and color.

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Impulse Buying Behavior: A Study for Apparel Industry

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ABSTRACT

Consumers buy Apparel products not only because of basic need to them but also because of sudden urge to buy them. The impulse buying has been investigated by marketing researchers and practitioners past many years. The purpose of this paper to provide detailed literature review of the impulse buying behavior of consumer by compiling various researcher work in the field of online & off-line apparel retailing. Apparel consumer browse the retail store to get an idea about latest trend and style, rather than relying on shopping list, the greater the possibility of impulse purchasing. Moreover, consumers are likely to be more divergent on what they want than what they need. This suggests apparel as a product category as stimulus effecting impulse purchases. The emphasis of this review paper is to understand the numerous factors which influence the impulse purchasing behavior like consumer, online/offline store, situational and product characteristics.

Keywords: Impulse buying, Retailing, Apparel consumer, Product Category, Stimulus

1. INTRODUCTION

Indian textile and apparel industry have ancient history of a fine craftsmanship and global presence. The textile and apparel industry is one of the largest industrial sectors in India and a leading foreign exchange earner also (Joshi, 2006). India is the second largest textile exporter in the world. In 2017, India's share in global trade of textiles and apparels was approximately 5 percent. In FY19, total textile and clothing exports stood at US$ 36.62 billion while Apparel (Ready Made Garment) exports reached at US$ 16.27. In the future, India's apparel exports are expected to increase considerably. Total exports of textiles and apparel are expected to touch US$ 82 billion by 2021 with CAGR of 12.06 per cent. The major market for Indian textile and apparel exports are: USA, Europe, Asia and Middle East (*Apparel And Garment Industry And Exports*, 2019). The Indian retail industry plays a vital role to increase the sale of apparel as an end consumer product. The Indian e- commerce and retail industry is one of the fastest growing industries in the world and played a critical role for overall development of the economy. The apparel consumer buying behaviors are changing rapidly, so the growth of apparel retail sectors not only limited to urban areas but it also growing in rural areas too. Many global brands are entering in Tier-I and II cities, while domestic brands are strengthening their position. In flow of international brands is creating deep changes in Indian apparel market. The apparel market consists of three categories: Men's wear, Women's wear and Children wear. The marketing strategies of the apparel segment are developed for multiple purpose viz. brand building and creating awareness about fashion and lifestyle-oriented image among the targeted customers. The young Indian consumers deliberate the appearance and image as the important. While the youth consorts' fashionable apparels as the basic factor for the lifestyle image, their buying consideration depends on affordability and its relevance with the latest fashion trends. The inspirational Young Indians are focused upon designed apparels (Shukla, Vyas and Pandya, 2018).

Apparel market is a homogeneous in terms of new styles and design, the apparel manufacturer attempts to distinguish the product through various method and visual practices in one such step that creates appeal of products thus enhancing the impulse buying behavior of consumer. This present study focuses on impulse buying behavior of consumer and its impact of apparel industry. Various external and internal factors influence the impulse buying behavior of apparel consumer.

2. LITERATURE REVIEW

Many research scholar and marketing practitioner have taken a very much interested in impulse buying for the past many decade (Clover, 1950; Stern, 1962). Impulse buying play a significant role in case of apparel shopping. Apparel shopper can get more benefits during impulse purchase, which is more important for apparel retail industry. (Abratt and Goodey, 1990) investigated that impulse buying in a supermarket could be of much interest to the manufacturer as well as retailer worldwide. (Piron, 1991) defining the impulse purchasing = Unplanned purchasing. Impulse buying is widely known as "Sudden or Unplanned buying" is a term used for any purchase made by a consumer without further planning. The young researchers and modem theorists are observant of impulse buying behavior of consumers and consider it as a unique and a continuous phenomenon in the lifestyle of the consumers living in this modem urban areas (Youn and Faber, 2000).

2.1 Definitions of Impulse Buying

Many researcher has given the definition of impulse buying but no integrated definition that can be approved in both academic and commercial literature (Fisher, 1995). According to the various retailer outlook, impulse buying is a sudden or unplanned buying. In a academic literature the definition of impulse buying focused on consumer standpoint and emphasis is on explaining the experience of consumer impulse purchase (Chang, Yan and Eckman, 2014). Various definitions of impulse buying given to many researchers, which is mentioned in Table 2.1.

TABLE 2.1: Definition of Impulse buying

Author	Definition
(Stern, 1962)	Any Purchase which a shopper makes but has not planned in advance.
(Weinberg and Gottwald, 1982)	Impulse buying is categorized as buying with great emotional instigation, with little cognitive influence and mainly responsive behavior.
(Rook and Hoch, 1985)	Sudden and Spontaneous desire to act.
(Cobb, C. J., & Hoyer, 1986)	Impulse buying is when an individual makes the decision to buy items while in the store.
(Rook, 1987)	The impulse buying is unintended, non-reflective reaction which occurs after being exposed to stimuli inside the retail store.
(Gardner and Rook, 1988)	Impulse buying is quick decision making and relatively biased in favour of instant acquisition.
(Piron, 1991)	Impulse buying is a purchase that is unplanned, the result of an exposure to astimulus, and decided on-the-spot. After the purchase, the customer experiences emotional and/or cognitive reactions
(Rook and MP Gardner, 1993)	Impulse buying as an unplanned behavior involving quick decision-making and tendency for immediate acquisition of the product
(Beatty and Ferrell, 1998)	Impulse buying refers to immediate purchases which are without any pre-shopping objective either to purchase the specific product category or to fulfill a specific desire.
(Block and Morwitz, 1999)	Impulse purchase as consumer buying an item with little or no deliberation after the result of a sudden, powerful urge.
(Kacen and Lee, 2002)	Impulse buying behavior is more arousing and irresistible but less deliberative when compared to planned purchasing behavior.

2.2 Categories of Impulse Buying

(Stern, 1962) identified four classification of impulse buying: Pure, Reminder, Suggestion and Planned impulse buying but (Han *et al.*, 1991)modified the classification of impulse mix in context of apparel products and developed a fifth type of impulse buying that is planned buying.

1) Pure Impulse buying
2) Reminder Impulse buying
3) Suggestion (Fashion oriented) Impulse buying
4) Planned Impulse buying
5) Planned buying

Pure impulse buying occurs without any previous thought or plan to buy. It can be described as a novelty or escape buying and results from a sudden urge to buy something, not necessarily something new or fashionable.

In **Reminder impulse buying**, the shopper remembers the previous decision or experiences which causes an on the spot impulse purchase.

Suggestion or fashion oriented impulse buying occurs when the consumer sees the new product (Apparel) in terms of new style, color, design and fabric, and suddenly decides to buy it.

Planned impulse buying occurs when consumers purchase is dependent upon sale/promotional conditions such as special less prices, coupon offers, and the other promotional offers; that is, this shopper waits to see what is available at what prices and then decides. The buying decision is not planned and is made in the suddenly in store.

Planned buying occurs when the purchaser has a list of specific items in mind before entering the store and then buys only those items which is available in list.

3. FACTORS AFFECTING IMPULSE BUYING BEHAVIOR

Most of the research related to impulse buying behavior studied the causes of an impulse purchase. According to (Sirhindi, 2010) two basic types of variable that can cause impulse buying behavior are:

1. External Factors of Impulse buying
2. Internal Factors of Impulse buying

External factors or stimuli refer to marketing stimuli or product characteristics that are controlled and placed by marketers in attempt to attract the consumer to make buying (Dawson and Kim, 2009). Further these factors can also be described as product related characteristics and store related characteristics.

Internal factors or stimuli emphasize on the individual, it refers to internal stimuli and characteristics of a consumer that make them engage in impulse buying. Situational stimuli and related factors also play a significant role for consumer impulse buying behavior.

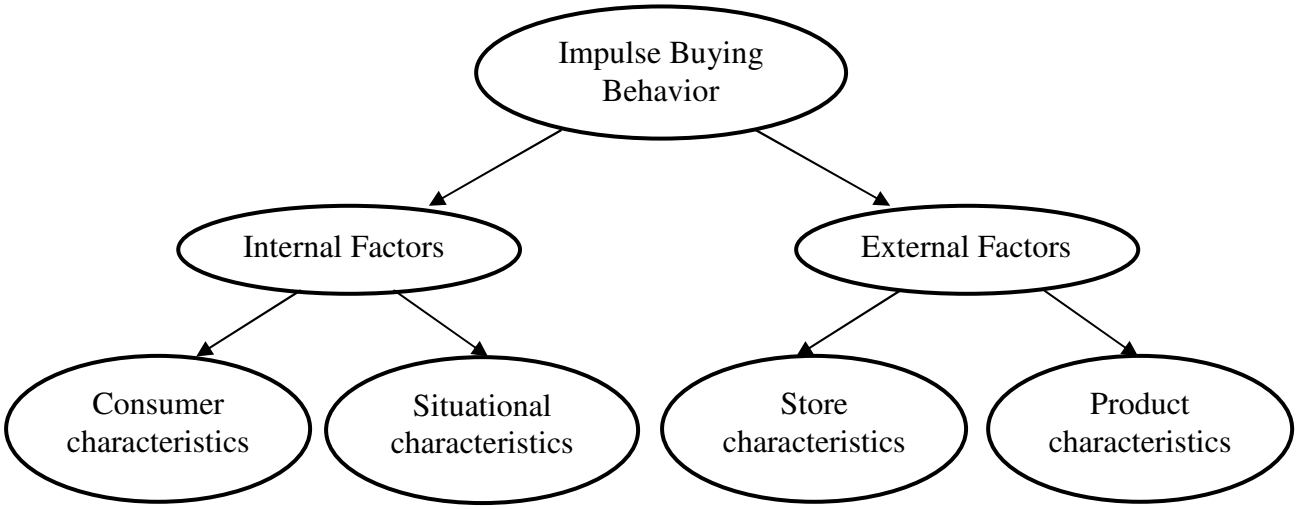

Fig. 3. Different factors of Impulse Buying Behavior

3.1 Consumer Characteristics

Consumer characteristics includes age, gender, mood, income level, materialism, shopping enjoyment and impulse buying tendency. Previous studies on consumer characteristics have found that young purchasers do more impulse buying then elder shoppers (Helmers *et al.*, 1995). According to (Logue and Chavarro, 1992) age and impulse buying have negative relationship between each other; that means young shoppers have less self-control over their shopping behavior rather then elder shoppers. Another characteristic is gender which also affects the impulsiveness. (Dittmar, Beattie and Friese, 2004) found that men and women do not have similar kind of preferences, when they do purchase. Men generally pay for products with practical and instrumental application and they mostly consider personal identity when they do shopping, on the other hand women select products which are associated with emotions and relationships and they mostly consider social identity when they do shopping. Previous studies also found that consumer's mood also influence the

impulse buying behavior of shopper. According to (Faber, 1996) negative moods affects impulse buying behavior of consumer. So, impulse buying can help the shopper to change their mood from negative to positive. Shopper who consider value with a materialism point of view mostly avoid impulse buying. They mainly choose to save money rather then spending money on impulse buying (Tatzel, 2003). These consumers usually do not affect by impulse buying. Another important characteristics is impulse buying tendency (IBT), which is associated with the lifestyle of consumers (Rook, 1987). Consumer with high amount of impulse buying tendency (IBT) are more probable to have desire to purchase various types of products impulsively (Jones *et al.*, 2003). According to (Bellenger, D. and Korgaonkar, 1980) purchasing is fun for some customer and they sometimes spend their spare time on shopping, but they do not purchase any product. Therefore, customers are shopping and enjoying their time, vendors may encourage them to stay longer at their shops and stimulate them to do impulse purchasing (Bellenger, D. and Korgaonkar, 1980).

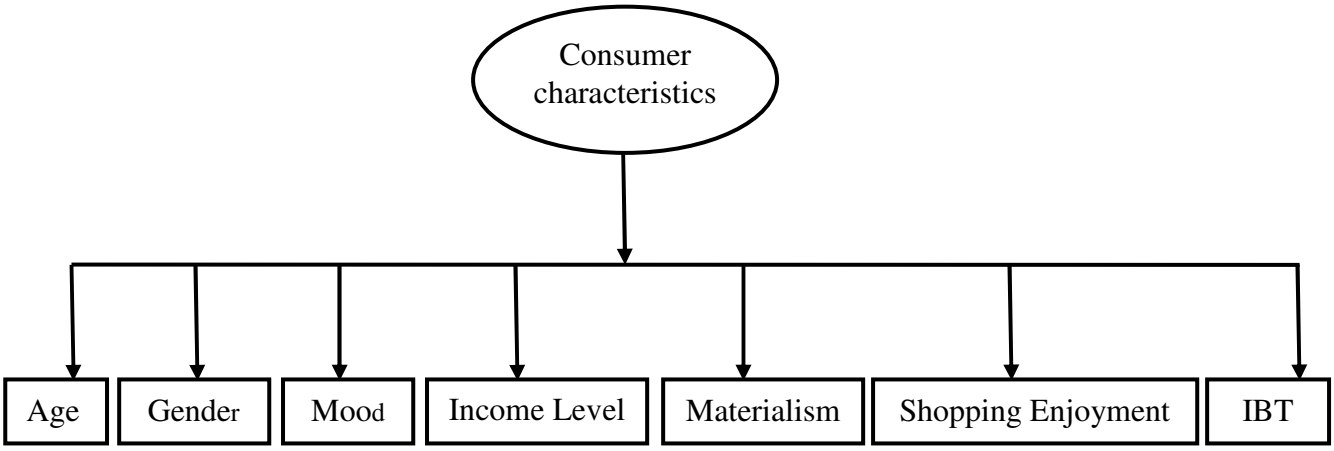

Fig. 3.1 Consumer Characteristics

3.2 Store Characteristics

Earlier studies related to store characteristics have suggested that the environment of the store is directly linked to individual buying behavior (Donovan, Robert. J and Rossiter, 1982; Beatty and Ferrell, 1998)proposed the idea of store environment and defined it as an attempt to design the environment of the store to generate certain emotional and motivating effects in the consumer's mind that ultimately increase buying chances. According to (Faber and Christenson, 1995), the tangible factors a store environment comprises of are equipment, color scheme, store cleanliness, store layout, product display and arresting interior decoration. On the other side the intangible factors consist of fragrance, temperature, lighting and music (Donovan *et al.*, 1994).

Design factors in a retail environment such as visual elements and physical facilities are deemed as direct sensory stimuli and general design factors include color, shelf space and store layout (Baker *et al.*, 2002). Visual merchandising display is exhibition of products that influence individuals' buying intentions and through the right product display retailers intend to offer consumers the right product at the right time (Baker, Levy and Grewal, 1992). Store layout may increase a consumer's interest in store environment and therefore attain customer attention (Bloch, Ridgway and Sherrell, 1989).

Social factors in a store consist of consumers and salespeople present in the store. Behavior of salespeople in a retail outlet has a key influence on individuals' buying decisions (Baker *et al.*, 2002). Another factor is crowding which is complex as well as essential to store environment (Michon, Chebat and Turley, 2005). Crowding along with store ambience, design and social factors are more significant element that is considered to influence individuals buying behavior. Crowding in a store is the outcome of social, personal and physical factors that stimulate individual towards potential problems evolve due to limited space (Eroglu and Machleit, 1990).

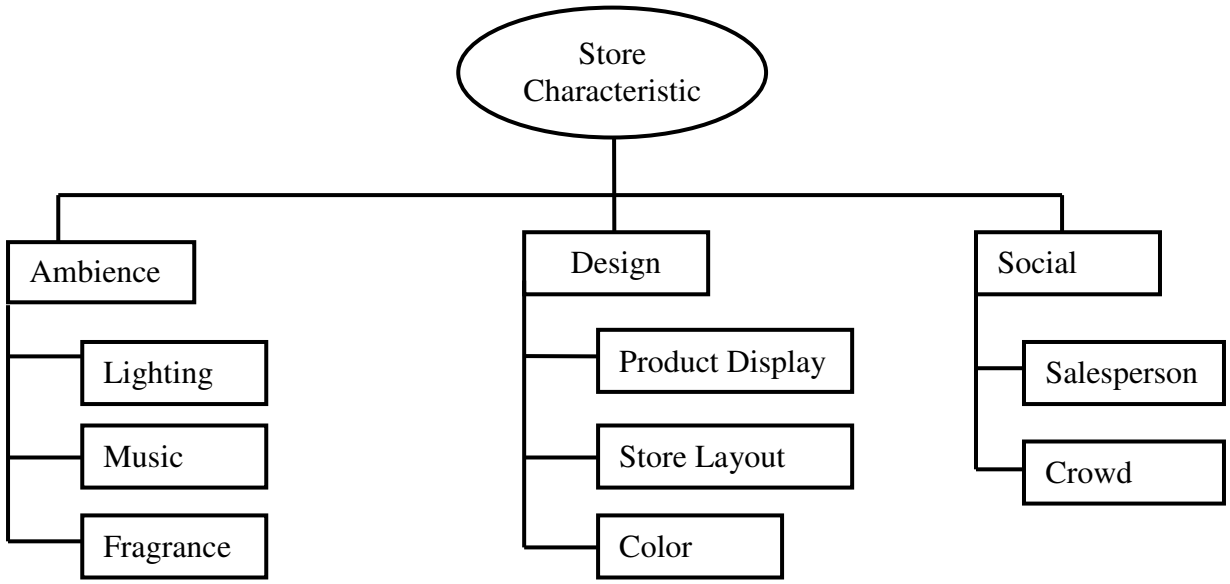

Fig. 3.2. Store Characteristics

3.3 Situational Characteristics

Situational stimuli or characteristics consist of an individual and environmental aspects that encourage consumer towards impulse buying. Situational factors include availability of time/ money, presence of others and sales promotion (Dholakia, 2000). (Duarte, Raposo and Ferraz, 2013) suggested that impulse buying behavior of consumer may be affected by special discounts and promotional offers, these activities fulfill the psychological requirement of consumer. Availability of time and money are another situational factors and main key element in a process of impulse buying (Beatty and Ferrell, 1998). Availability of time during shopping determines whether an individual will get involved in impulse buying or not and limited time during shopping has negative effect on impulse buying as individuals will possibly feel frustrated because of limited time. Therefore, if individuals have extra time then they will spend additional time in a store and they will browse further (Beatty and Ferrell, 1998).

Availability of money enhances the consumer's buying power and limited availability of money can decrease the chances of impulse purchasing (Beatty and Ferrell, 1998).

In a shopping situation, presence of others will possibly influence the purchase decision; such effects may possibly occur irrespective of whether the others are family members or peers (Aribarg, Arora and Onur Bodur, 2002).

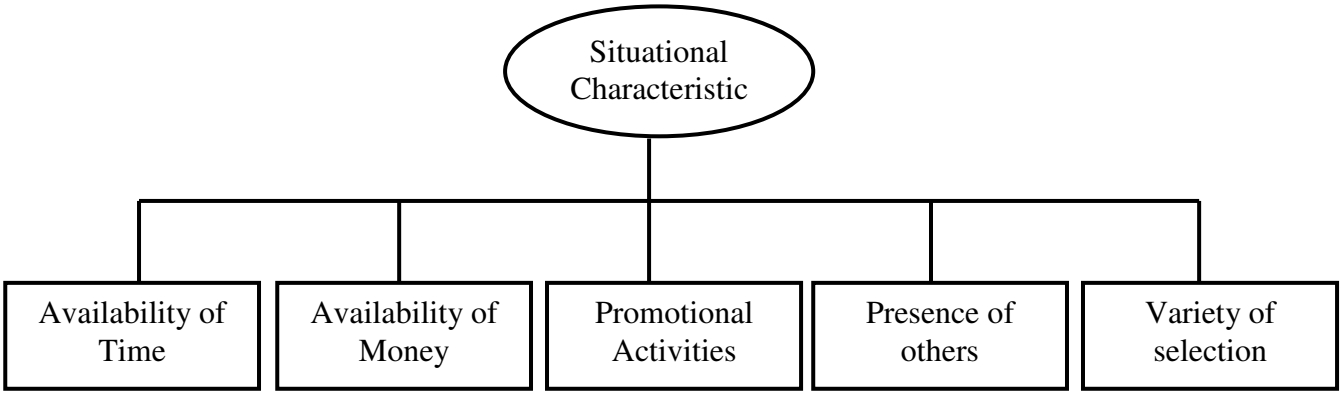

Fig. 3.3. Situational Factors and Characteristic

3.4 Product Characteristics

Earlier studies on impulse buying categorize products as impulse and non-impulse items. Many studies examined the frequency of impulse purchasing indifferent product class (Applebaum, 1951; West, 1951). Now a day's Impulse buying behavior still discussed regarding different types of products which are or are not impulsive (Belleneger, Roberston and Hirschman, 1978). According to (Jones *et al.*, 2003) product characteristics can also influence the impulse buying behavior and Variables such as the appearance of products in the retail environment and some of the product features have been suggested to be effective on consumer impulse buying behavior(Beatty and Ferrell, 1998). According to (Dittmar, Beattie and Friese, 1995) studied clothing are the most likely shopper for impulse buying and clothing are "consumer goods which appear to have potential for self-presentation, self-expression, mood adjustment, diversion and entertainment.

Product price and type has also been found to be an important aspect of impulse buying (Zhou Lianxi and Wong Amy, 2003). (Youn and Faber, 2000) find that shoppers are buying impulsively, when there are sales available and product are on discount prices. Products which are purchased on impulse are generally inexpensive. Moreover, previous studies show that products are generally purchased impulsively based on their characteristics.

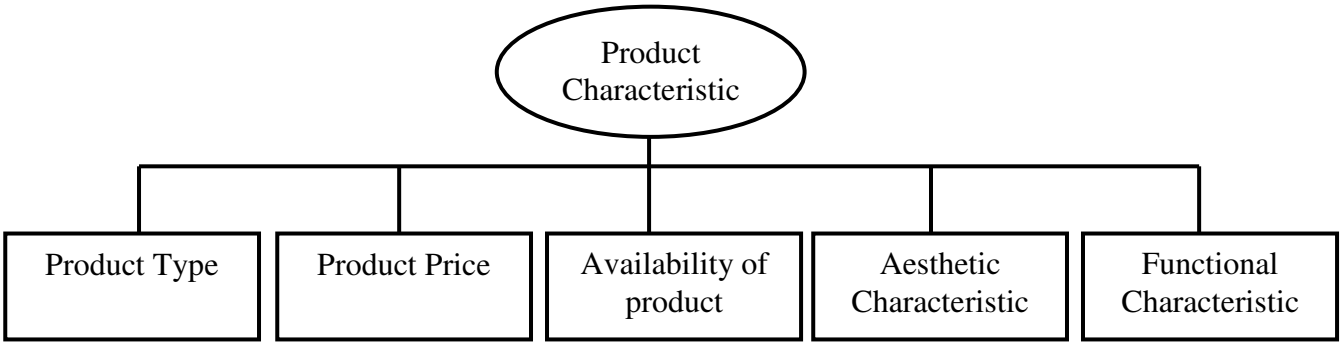

Fig. 3.4. Product Characteristic

4. RESEARCH FRAMEWORK AND FUTURE RESEARCH

After the detailed review of the literature and many research papersanalyzation we have derived some predictions for the future research endeavors in the field of impulse buying. In this paper, we propose a framework to increase the understanding of impulse buying behavior. After analyzing the various factors studied in the past studies, we formulized four different groups which could accommodate the various factors. Therefore, we have categorized the various factors under the broad categories of "External Factors or Stimuli", "Internal Factors or Stimuli". In this paper four broad categories evaluated under external factors and internal factors, these are Consumer, Store, Situational and Product related characteristics.

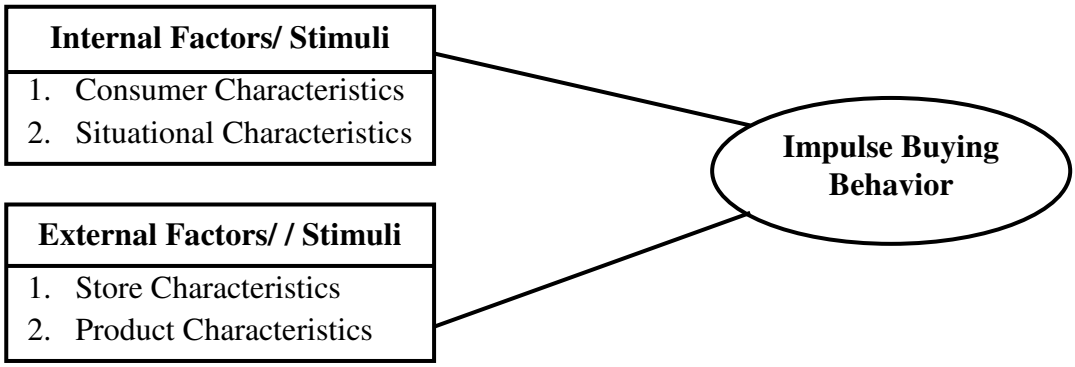

Fig. 4. Research Framework for Impulse buying behavior

Based on the literature review, we now produce a set of research propositions that could help in developing the knowledge on this area of impulse buying behavior. Our proposed model captures the different aspects of impulse buying of the consumers. In this part of our literature review, we have explored four propositions that a rise from the above derived conceptual framework. The future researches could be done under the following lines:

- **E1**- Effect of various Consumer Characteristics on Impulse Buying Behavior
- **E2-**Effect of various Situational Characteristics on Impulse Buying Behavior
- **E3-**Effect of various Store Characteristics on Impulse Buying Behavior
- **E4-** Effect of various Product Characteristics on Impulse Buying Behavior

These four-dimensional research frameworks could be further hypothesized in the future research attempts and studied through exploratory studies. Among these four implications of research, the most challenging implication of our research is the effect of the store characteristics and situational factors on the consumer's impulse buying. With the technological development of the retail store formats, only store related aspect is fully under the control of the marketers. External stimuli or factors could be leveraged by the retailers by framing suitable retail strategies to tap the potential consumers inside the store. Future research studies could be extended in this field by analyzing the interactive effects of the various factors and the shopper's personal traits.

5. CONCLUSION

Impulse buying is a composite phenomenon which is a challenge for apparel manufacturer and researchers to understand the shopper's behavior. Marketing researchers have mainly focused on evaluating the different factors that encourage impulse buying in various developed nations. In the growing economies, there is a need to study the consumer impulse buying behavior, due to recent advancement in online and offline retail environment and huge cultural differences when compared to different developed countries. Increases in personal income, lifestyle and easy availability of money (credit) have made an impulse buying omnipresent phenomenon across the different apparel buying formats. Creating an attractive visual merchandising display in retail environment and in-store atmosphere is important to increase the sales through unplanned impulse buying. Due to the technological development, present scenario provides with a huge opportunity for the end consumer to gravitate towards impulse buying in both contexts i.e. offline and online shopping mode. Also, socio-cultural factors namely culture, tradition, religion also play imperative role in affecting the impulse buying. After the detailed literature review it can be concluded that the phenomenon of impulse buying has various dimensions such as store/website atmosphere, situational factors and relationship with the shopper, can lead to strengthen the knowledge and implication in the field of consumer buying behavior. Based upon the changing trends of apparel market in the developing countries, it is important that impulse buying may turn into a growing area of future research and could be seen across the various formats.

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Influence of Visual Merchandising on the Consumer

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ABSTRACT

Purchasing is visual. What is seen is what is bought. Brands have recognised that value and are promoting themselves to attracting the consumer's eye. Displays have to attract, engage and motivate the customer on merely a visual appeal. Consumer behaviour is visual and tactile too and buying is done with the senses. The need to see, to touch and when that is all pleasing it effects in a buy, has kept marketers and retail specialists invest in specialist visual merchandisers, to engage more buyers.

Visual Merchandising now goes beyond just mere store window display; it is all about creating the 'experience' for shoppers. And that is in the manner it is displayed. While online stores may not have the tactile feel the visual appeal is high and this has been beneficial to brands.

This paper attempts to explore the development of Visual Merchandising and the dynamic tastes of the consumer, of how products need to highlight their strengths and benefits to invoke a buyer's desire through visual presentation – be it in-store (physical) or online (virtual).

Keywords: Visual Merchandising, Consumer Behaviour, Fashion merchandising, Retail, Branding

1. INTRODUCTION

Brand Marketing is all about ensuring that a product is seen for consumers to notice it to effect a purchase. Marketing relies on the visual factor and this has led to various forms of above-the-line (ATL) and below-the-line (BTL) advertising, (Rapp and Collins, 1988). Traditional marketing invested a lot in advertising and pushing the product into retail market and stores. Social Media, - Facebook, Instagram, Twitter and YouTube and even LinkedIn posts, have taken this a step further and ensured that a product gets 'eye-balls' or viewership. Social Media has garnered a following and a claimed authenticity, and being faceless and with multiple channels, they earn the trust of consumers. This has led to garnering a grand following vitally important to the sale of products and brands - a following and viewership that gives the brand ownership and increased sales.

But what is that one aspect that consumers want that leads to a purchase? Simply put it is 'Value.' What is sold by marketers is value. Value is the hidden aspect that all brands – be it products or personalities – like to showcase their hidden qualities. It is a human tendency to want what is viewed visually, and it is the new segment of Visual Merchandising that is now gaining ground in the marketing lexicon.

In Branding and Visual Merchandising, there is also a higher thought for sustainability and an increased number of companies are improving methods to ensure a better planet. Sustainability in visual marketing too has been enhanced, keeping in mind novelty and the dynamics in their optical value.

2. INFLUENCE OF VISUAL MERCHANDISING ON THE CONSUMER

Consumers want change and that impulse for a different aspect in lives lies in everything from food, to clothes, to accessories, to home furnishings, to lifestyle products, to name it, everything is cyclical in the home and what prompts buyers is advertising and visual information. Stores and the online world fill our inbox with the enticements of a sale, or a new addition, or a unique category of products. 'A must have' is promoted. It is almost the Maslow's hierarchy that states that self actualisation is felt in consumers getting their wants. Consumers 'want' a product even if they don't 'need' it. It is self satisfaction.

Consumers buy, and buy a lot. According to research done by Statista, consumer spending across India amounted to over Rs.19.7 trillion in July 2019. Although this was an increase compared to March 2017, consumer

spending had decreased since January 2019. Even if the market in India shows a slowdown, consumers' trends on buying have not curtailed much in terms of disposable everyday purchases.

In fact there is a 'button' inside our brain that pushes us to buy something. Patrick Renvoise, co-founder and the chief persuasion officer of *Sales Brain*, talks of a very vital component related to human behaviour towards accepting anything. According to him, there is no such thing as a rational decision. There are nearly 188 cognitive biases inside the human brain that affect purchase decisions and based on that marketers need to strategise. And it is this strategy that brand marketing espouses to the fullest.

Purchasing is visual. What is seen is what is bought. Brands have recognised that value and are promoting themselves to attracting the consumer's eye. Displays have to attract, engage and motivate the customer on merely a visual appeal. Consumer behaviour is visual and tactile too and buying is done with the senses. The need to see, to touch and when that is all pleasing it effects in a buy, has influenced marketers and retail specialists to invest in specialised visual merchandisers to engage buyers. It is all about grabbing eyeballs.

3. VISUAL MERCHANDISING

This physical display of products in the most intriguing and appealing manner is termed as Visual Merchandising. It is displaying the product in images and/or styling which appeal to the consumers' senses. And it is related to sight; the ability to be attracted by visual appeal, which turns an onlooker or a passive buyer to an adopter or an active buyer.

Visual Merchandising entails creative use of floor plans and three-dimensional displays in order to maximise sales. Appealing and attractive utilisation of displays, colours, lightning and sounds are utilised to invite, attract, engage and motivate a consumer to make a purchase. Visual Merchandising relies on the science of placement that would appeal to consumers. This has become a vital subject in Fashion education's curriculum and many international fashion schools have short-term and degree courses in Visual Merchandising. Students are being trained in the art of styling and in-store displays; retail interfaces and online on the web. It is the art of enticing a consumer enough for them to believe in and an increased desire to embed in them the 'need to have' a product. The courses teach students to proceed with a clinical and psychological approach towards mind-bending the consumer's tastes and increasing their wants.

In-store branding and window displays have to communicate with the customer. It is concept selling the brand. Visual Merchandising now goes beyond just mere store window display; it is all about creating the 'experience' for shoppers. Displays have to attract, engage and motivate the customer on merely a visual appeal. In effect, we buy with our senses. We need to see, we want to touch and when that is all pleasing it effects in a buy.

Online stores may not have the tactile feel but the visual appeal is high and this has been beneficial to brands. For the online space, we demand alluring visuals to place our senses. This results in a sale. Emotionally and psychologically appealing the senses. The Happiness Index of purchase satisfaction.

Products need to highlight their strengths and benefits to invoke a buyer's desire. Presentation is the appeal. Surrounding this presentation is the performance of a brand. We intuitively understand the importance of displays and the perception and illusion of a product's high points which create a desire. It's eventually all about the bottom-line or sales. The Visual Merchandising strategy is complete.

4. PRACTICAL SIGNIFICANCE/USEFULNESS

Visual Merchandising makes it easier for a consumer to locate a product and self-select. Some displays suggest ways and educate the consumer how to wear a product in case of garments, or how to use a product. It also is a way of moving slow sale products – make it enviably attractive to the buyer, and they will pick it off the shelf, or online store.

The purpose of a display is mainly to sell; secondary is to enhance brand image and overall business image. This generates impulse sales. Creative displays always gain a higher eyeball which lead to sales. Purchase power is buying something only to the degree that the product which is bought gives us the promise that it will help move emotions. It is a manner of making things memorable which form a core part to reach out to the consumers. This is what the consumer will remember about what the purchase promise is. What was conveyed to them at that very moment. The decision to buy or not

to buy depends on an emotional and psychological wrangle.

Hence, it is optimising what is communicated to the customers today so that in three days, three months, three minutes or three seconds, a purchase is made. What happens at the moment is the brand promise that is fulfilled now or later. Large store brands use that power to connect with buyers on a very emotional level.

5. SUSTAINABILITY IN VISUAL MERCHANDISING

The earth has limited resources and retail merchandising departments play a critical role in deliberating sustainable practices in products to sell and to be displayed, and in what manner they are to be showcased; all this keeping in mind on how to reduce costs and minimise supply chain risks and yet attract consumers. Sustainability represents a lever for merchandising to reduce risks and costs by increasing visibility and efficiencies along supply chains, markets and stores branding.

The success of Visual Merchandising depends on a proper marketing and advertising strategy, involved with proper presentation, packaging, keeping in mind colours, shapes, textures, signages, lighting, POS (point of sale) material and festivals & other celebratory days too, (Ogilvy, 1985). But the main future of sustainability is utilising material that is re-usable and environment-friendly.

BBC reports that there is a sea of plastic in the Caribbean. And it should be everyone's personal decision to lower usage of plastic and unsustainable material. Reduce, Re-use, Recycle is the well and timely mantra for today. But there is good news, companies are increasingly being aware of their unhealthy and unsustainable methods. The fashion industry, the plastics industry, in fact, Huhtamaki PPL India, a company that started out in plastic packaging, is now looking at various ways to ensure sustainability in the marketplace. Recycled plastic, renewable methods and innovative technology is used to save the planet.

Omo, the washing soap brand from Unilever, was one of the first brands in the Indian marketplace to utilise recyclable shopping bags, much before the ruling on plastic, or the single-usage plastic ban in June 2018. Omo and Unilever are dedicated to environment-friendly sustainable activities. And advocate various ways through brand merchandising promoting the safer and cleaner use of material.

Mongabay, the site for news from Nature in India, too talks of sustainable activities in different spheres. Why shouldn't Visual Merchandising be any different? Stores are now promoting recyclable material and re-usable storefronts towards a better planet. A study conducted by the Iowa State University the findings suggest that consumers' attitude toward sustainable Visual Merchandising practices are a strong indicator of their willingness to buy and intention to patronize such retailers. This ultimately results in store loyalty, and increased bottom line. A better planet, a wider buying reach.

Consumers now have higher environment consciousness to various items. They will emphatically promote and pursue a brand that deals with better nature conservation methodology. Retailers have to gain immensely by implementing more sustainable Visual Merchandising practices. This should emphasize efforts in advertising and marketing which will help to ensure store loyalty. Here retailers will not only contribute to the cause of saving the environment but also lead to profitability and store loyalty.

6. CONCLUSION

There has to be synergy with the store and brands and add to that is environment consciousness and the carbon footprint. Inconsistency in anything, visual execution, poor lightning, confusing traffic patterns, (in-store movement details), signage and prop overload, makes it feel too much out of the way and there is a disconnect with the buyer. The design has to be consistent with image and strategy and that influences consumer behaviour. It is the cost v/s value debate that comes into play and nothing can dislodge a consumer's purchase if there is a miss in image and strategy.

While the great marketing guru Philip Kotler propounded the 4 Ps of Marketing (Kotler, 1989), they too are the same in value for Visual Merchandising – Product, Placement, Pricing, Promotion; the consumer eats with their eyes. Visual Merchandising takes that to meet the consumers' dynamic taste and lifestyle. Visual presentation should meet this desire and meeting it thus lands a sale.

Thus the perceived value in a product is more often seen through the lens of how a product is displayed. The

development of Visual Merchandising and the dynamic tastes of the consumer have reflected this position. Products need to highlight their strengths and benefits to invoke a buyer's desire through visual presentation – be it in-store (physical) or online (virtual) and the effective sale is complete. The physical aspect is buying; emotional angle deals with sustainability.

The visual expression of a consumer's experience deals with many factors but the fulfilment of a brand's promise is from optical illusions to reality; from the mind to the purse; from brand loyalty to sustainable brands. And that is the deeper story of Visual Merchandising.

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Artificial Intelligence: Automating the Fashion & Textiles Industry

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ABSTRACT

Over the last two decades, because of the boundless progression of computer technology, research in artificial intelligence (AI) and its applications in fashion and textile industry has become a much discussed topic and has received greater attention from both academics and industrialists. The study focuses on the validity of data created by various mobile platforms, social media interactions, and e-commerce transactions in the emerging online fashion business. The study helps to deliver an opportunity for researchers and practitioners to study and develop systems for understanding consumer behaviours and tailoring the services of online platforms by effective use of AI. Arising from the above, a number of AI, machine learning and computer vision related techniques has been successfully employed and proven to handle the problems and provide valuable solutions to the industry like fashion sales forecasting, supply chain optimization, planning and scheduling, textile material study and defects, fashion and textile image recognition, fashion image and style retrieval, Fashion styling, human body modelling and fitting, etc.

Keywords: Artificial Intelligence, Digital transformation, automation, sustainability, personalization

1. INTRODUCTION

Fashion and textile industry has been traditionally labour-intensive but it is evident in the recent times that world's largest fashion apparel brands have a significant portion of their products manufactured in Asian countries such as China, India, Bangladesh, Vietnam, etc.

Historically, much of the movement in textile business to the East materialized over the past couple of decades when labor costs began rising in Asian countries (markedly China). With accumulative dissemination of industrial automation in the industry, textile manufacturing businesses with access to historical and real-time operational data can leverage Artificial Intelligence to improve effectiveness and supplement the proficiencies of their human employees. Artificial intelligence is the study and advances of clever machines and software that can reason, acquire and assimilate knowledge, converse, influence and distinguish the objects. John McCarthy coined the term in 1956 as branch of computer science which created computers that would behave like humans. It is the study of the calculation that creates possibility to recognize reason and perform. Artificial intelligence is considered to be responsible for constructing machines which are far cleverer and more beneficial. It works with the help of artificial neurons (artificial neural network) and scientific theorems (if then statements and logics). AI technologies have matured to the point in offering real practical benefits in many of their applications. Major Artificial Intelligence areas are Expert Systems, Natural Language Processing, Speech Understanding, Robotics and Sensory Systems, Computer Vision and Scene Recognition, Intelligent Computer Aided Instruction, Neural Computing. From these Expert System is a rapidly growing technology which is having a huge impact on various fields of life. The various techniques applied in artificial intelligence are Neural Network, Fuzzy Logic, Evolutionary Computing, and Hybrid Artificial Intelligence.

It is needless to say that technology has always played an imperative role in automating fashion. Yet, it is with the dissemination of digital technologies and the affluence of data fashioned by these technologies, that is the digital transformation – that the fashion industry started initiated a more reflective and rapid transformation which is varying the way in which consumers buy and interrelate with products and brands. Fashion & Textile industry is making use of these technologies to accomplish their supply chain targets better or are using real-time data and analytics to

estimate demand better and augment pricing. This is certainly very useful in apprising fabrication decisions, enhancing planning and logistics and tailoring products.

According to the OECD (2019): "Digital transformation denotes the financial and social effects of digitization and digitalization. Digitization refers to the transformation of analogue data and practices into a machine-readable format. Digitalization refers to use of digital technologies and data comprising of interconnection that outcomes in new or changes to existing undertakings. Digital revolution entails two processes: digitization and digitalization. Digitalization makes use of digital technologies, data and interconnections to change or create new activities.

Interconnection of devices and networks has facilitated the progress of digitalization and has been at the heart of the dissemination of information and communications technologies (ICTs)

Artificial Intelligence making sweeping changes in the Fashion & Textile Industry

The fashion industry is at a turning point. The McKinsey Global Fashion Index forecasted that industry sales growth will triple in the next 2-3 years.

This growth was predicted on the basis of two occurrences: 1) The West will not play the foremost character in fashion sales any more and more than half of Fashion sales will come from emerging market countries across Asia-Pacific, Latin America and other regions; 2) The acceptance of digital technologies such as mobile internet, progressive analytics, virtual and augmented reality, advanced robotics and artificial intelligence are overpoweringly changing the Fashion industry and setting the stage for a strong trend towards a significant segment of digital adoption by mainstream consumers; these progressions are geared to match some specific trends in consumer and enterprise behavior.

Source: mc.ai

2. OBJECTIVES OF THE STUDY

Objective of the present study are as follows:

a) To understand and discuss the meaning, relevance and applications of Artificial Intelligence: in the Fashion & Textiles industry

b) To deliberate on how Artificial intelligence has made sweeping changes in the Fashion & Textile Industry

c) To discuss the changing Trends in Fashion & Textile industry due to use of Artificial Intelligence

d) To understand and appreciate the Automation in the Fashion & Textile Industry as a result of Artificial Intelligence

3. RESEARCH METHODOLOGY

The nature of the study is qualitative in nature and with the use of secondary data. The nature of the study is

qualitative in nature and with the use of secondary data. The Research is purely descriptive in nature

DATA & SOURCES OF DATA:

The data has been collected from various websites and books

4. FINDINGS

4.1 Applications of AI

Fashion is considered to be one of the most valued sectors in the world. Its estimated worth is about $3 trillion, expressive of 2% of Global Domestic Product (Sennaar 2019). However, this industry has remained quite traditional for decades but with the progression of digital transformation, it is also commanding thoughtful revolutions on the fashion industry. In particular, the abundance of data made available by the use of digital technologies has enabled the diffusion of many applications of AI in this industry. The most widespread applications are in the domain of customer services, bringing the ability to capture the trend of customer personalization by enhancing customer experience online and in stores.

With the Fashion movements continually shifting, Artificial Intelligence is being used to promptly analyse vast expanses of consumer data to precisely predict forthcoming trends. Many businesses have started implementing AI in their stores, using shopping assistants reachable by mobile devices to enhance the consumer's involvement by providing product endorsements, or executing smart mirrors which scan a consumer's appearance to recommend merchandise that fit best. More lately, companies have begun using AI in the conception of fashion designs

Source: Becominghuman.ai

4.2 Artificial intelligence for creating sustainable fashion

The fashion industry is known to be causing pollution, to necessitate raw materials like leather in excess of global supply. Also in order to consume a huge amount of water to dye fabric and to yield a great waste of fabric due to recent trends of fast fashion.

"Every week a new trend appears, every month a new wardrobe. From 2 seasons a year, fashion businesses are pushing up to 6 seasons a year to their clients as if they were inescapable" (BAGAAR 2018).

Many brands claim that apx 50% garments produced by end up in a landfill or are destroyed within the first year of production. Sustainability is something which is being most talked about in the Fashion Industry. To be more sustainable there is a need in the Fashion Industry to start from new types of textile and innovation and use of biotechnology which is certainly playing a great role. Shrilk, a material made from discarded shrimp shells and

proteins from silk, is very strong but much lighter than 44 aluminum; materials like Viscose, Tencel or Lyocell are all biodegradable and much more economical in their use of energy and water compared to cotton (BAGAAR 2018).

Also, high end labels have initiated the production of sustainable garments using recycled fabrics or organic materials such as orange peels, mushrooms or even algae (Ricci 2018).

Finally, AI can certainly guide the fashion business towards a more sustainable background, augmenting retailers' business models and making them less extravagant.

AI also has the prospective to utterly interrupt the fashion industry, not only because of new commercial models and new ways of manufacture but it certainly will have an influence on the individuals engaged in the fashion industry and on their jobs

Artificial intelligence (AI) is sometimes considered to be less highly ranked. Major Fashion Players including Amazon, Alibaba, Myntra and Stitch Fix have made progress across various areas of the value chain and others will follow suit. Ananth Narayanan, chief executive of Myntra, remarked that, "for curation and assortment, we are using a lot more data science to tell what will sell. I think that could extend a lot more into manufacturing and the back-end system and we are doing parts of that already at Myntra. It's not about having the largest assortment; it's about offering the most apposite variety to the customer involved."

The same may be done through:

1) **Better demand and sales forecasting**– Sales forecasting through AI that will minimalize waste merchandises through decrease of overproduction and an optimal provision of merchandising

2) **More operative and transparent supply chain management**. - Besides better supply chain management, AI can also help in providing more transparency in the supply chain, by providing material on what raw materials are used and where companies are sourcing their labour.

3) **Offering Personalized shopping experience to consumers**: With the new concept of marketing, all brands are making sure to have a better information about consumer preferences that will make it likely for Fashion brands to reduce waste and the number of unsold goods (de Freitas 2018).

4.3 Predictive analytics and AI for trend and demand forecasting- The watchword 'predictive analytics' includes a group of techniques from statistics to machine learning that uses historical data to make predictions using models. A model in predictive analytics is an algorithm that uses the data of the past to forecast the future. In fashion, one of the most common applications of predictive analytics is the size recommendation to match a consumer with the size that will best fit them for a given garment.

Fit Analytics, based upon the information provided by the customers (height, weight, age and fit preference) through its interface Fit Finder, returns a best-fit recommendation. Fit Finder powers more than 500 million recommendations every month and is used by many fashion brands such as The North Face, ASOS, Tommy Hilfiger, Amaro.

Predictive analytics is certainly very helpful in finding out which consumers are more expected to make a purchase, and which are likely to leave the platform. It is also helpful to fight frauds and detect distrustful transactions. It certainly offers demand forecasting for consumer goods and services AI could also be principally very helpful in pursuing fashion trends.

4.4 Artificial Intelligence for Product, inventory and supply chain management - Due to the incompetence of predicting demand, supply chains experience a surplus of some products and a shortage of some others (Fisher 1997). The same stands very relevant for fashion industry's supply chain as well. In order to manage a supply chain effectively it is vital to understand the nature of the demand for the products one's company supplies. According to Fischer (1997) the product demand depends on numerous aspects including its Fashion life cycle, merchandise variety and other factors. Demand forecasting for the fashion industry is becoming principally stimulating due to the shifting nature of the industry itself. Indeed, the product life cycle is becoming shorter since the Fashion now is Fast & short.

4.5 Artificial Intelligence for operations automation – As per Luce (2019), the word robot is often used in the Fashion industry to define a robot as a programmable

machine responsible for carrying out composite actions. It is actually considered to be the physical quintessence of artificial intelligence that takes action in the corporal world. In the fashion industry, manufacturing robots are widely used for sewing as well as for supply chain management. In factories, robots are used for sewing. Using sewing robots has noteworthy recompenses in cost reduction, reshoring fabrication, reducing wastage and therefore safeguarding the environment, building sustainability and increasing manufacturing flexibility (Luce 2019). But, beyond the use in factory, robots in the fashion industry are used in the store room for picking and packing processes.

Source: Fashionretail.blog

4.6 Artificial Intelligence for the Design process – Artificial Intelligence is becoming very much widely used in Fashion Design process. In 2018, Yoox, the leading Italian e-commerce company, presented 8 by Yoox, the first fashion collection designed using AI. A software amasses images and texts composed from social networking sites and articles from online publications; then an AI engine accumulates predictive indicators on fashion and buying trends, revenue data from Yoox websites and consumer estimations to create a mood board which is being used by human designers to produce Fashion apparel and accessories (Mazza 2018; Marchetti 2019). Amazon in 2017 announced generative adversarial network (GAN) to design Fashion apparel. These models can generate images of clothing and can be helpful as preliminary points for designers. IBM together with Tommy Hilfiger and the Fashion Institute of Technology (FIT) Infor Design and Tech Lab on a project called Reimagine Retail to show how "AI can support design teams by augmenting and plummeting overall lead times, and expand their imaginative innovation by analysing and memorizing perceptions from thousands of images and videos using computer vision.

It is very pertinent to mention that machine learning and computer vision technologies can be used to design the most innovative and quintessential fashion products that counterpart the incessant evolution of consumer preferences (Wong 2019).

4.7 Artificial Intelligence for developing SMART textiles -There is a specific effort of the Fashion & textiles Industry in creation of electronic textiles called Smart Fabrics that integrate digital components that offer an assortment of assistances to consumers from tailored fits to weather adaptability, release of medication, temperature regulation, heart rate monitoring, muscle vibration, self-cleaning etc (Bagaar 2018).

(source:https://www.intelistyle.com/ai-fashion-retail-innovation)

Electronic textiles known as "Smart Fabrics" enable digital components to be embedded in them for a variety of benefits from customised fit to weather adaptability.

5. AI CHANGING TRENDS IN FASHION & TEXTILE INDUSTRY

5.1 Personalization- According to the McKinsey 2018, personalization is acknowledged as the number one

trend for the fashion industry. Majority of Consumers have expressed a strong desire to use fashion to express their own style, image and morals. Research studies also state that consumers are becoming choosy, looking for exceptional items and merchandises with developed quality, exclusiveness and enhanced prices. Hence, fashion companies will offer personalization in many ways, ranging from more tailored products to making all possible efforts to augment consumer experience both in physical and online shopping. Firstly, this is consummated through customizing shopping experiences which is established on data collection and data analytics capacity.

Secondly, retail services offered in stores are enriched by facilitating smart dressing rooms, digital mirrors and automatic payments systems that saves a lot of time of the consumers.

Thirdly, 3D visualization is used in online retail for designing and personalizing merchandises such as shoes or clothes (OECD, 2019).

5.2 Online Platforms - According to the McKinsey 2018, consumers will consider online platforms as the first point of search, given the expediency, the diversity and range of offering. All these platforms appreciate sturdy direct and indirect network effects and offer benefits from economies of scale to users on both sides of the market. These platforms act as intermediaries between buyers and sellers on the internet and also enable the interchange of goods and services. Online platforms also help in providing a contrivance to diminish information unevenness between multiple parties and increase trust in transactions by making them safe and reliable. Platforms such as Amazon, Zalando and Myntra are promoting their own private label fashion offerings.

Mobile preoccupied Consumers will be progressively using mobile phones for web search, price comparison and their online purchases. The trend is well established in Asia. Research says that in countries such as Japan and South Korea, more than half of e-commerce transactions are made on a smartphone or tablet. In China, more than 80% of online shopping is done on mobile devices. Consequently, consumers will imagine fashion companies to offer convenient mobile transactions

5.3 Customer experience enhancement online and in-store

Chatbots or AI smart Assistants. The increasing scale and grossness of personalization in online fashion is apparently unmanageable without AI applications. The most popular services for personalized online shopping use chatbots or AI smart assistants. These are virtual machines that relate to consumers via chat, responding to customer service inquiries, helping users navigate ranges online and in-store, also recommending Fashion apparel and accessories that best suit a specific consumer as if they were human shopping assistants working 24 hours a day. Dior also uses a chatbot to interact with customers via Messenger on Facebook through the platform which is called Dior Insider. This service offers the possibility of using slideshows and links to the website, making the shopping experience much easier.

6. SUMMARY & RECOMMENDATIONS

With the advent of AI applications in Fashion & textile Industry, it is predicted that in 5 years it will be typical for people to stand in front of their TV and try on basic clothing. The world is confident that AI is going to transform everything about fashion retail… the supply chain, design, consumer experience: it is expected that the design process of clothing will be semi-automated in 10 years. AI is going to completely change materials and 3D printing and more Smart textiles will be dominating the Textile Industry.

This is a very wide field and lot of developments in the Fashion & textiles Industry.

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Artificial Intelligence in Fashion and Textiles

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ABSTRACT

This research focuses on the growing notion of artificial intelligence in the fashion and textile industry. It touches upon the meaning and subsets of artificial intelligence, while also explaining the AI methods that have/are being used such as Bayesian network, fuzzy logic etc. It explores the various AI programs that have been adapted by the industry such as robot warehousing, Cognex, data colour, virtual fitting room apps, 3D body scanning, use of crypto currency in products while also analyzing the possibility of various AI programs becoming the future of fashion- such as AI stylist, fashion++, using machine learning to identify previously hidden patterns from raw data, and other possibilities that might step in. The research also talks about the leading fashion brands and how they are instituting AI applications into their brands both at a retail and couture level and the ROI of these applications while also discussing if there are any similarities in their innovation efforts and if so, what does it mean for the future of fashion in regards to artificial intelligence. The study then scrutinizes how the role of artificial intelligence is going to affect the fashion and textiles industry as whole and who is going to benefit and forfeit from it.

Keywords: AI programs, future, machine learning, virtual.

In an ever-metamorphosing industry like fashion and textile manufacturing, some things have always remained constant. For example, little black dress, denim, and the paramount of all, the fact that it is a highly labour- intensive industry. So, this research paper addresses, artificial intelligence (AI) is making its place in the fashion and textiles industry and is growing stronger with time. Artificial intelligence can be loosely interpreted to mean incorporating human intelligence to machines. There are 2 subsets of artificial intelligence:

(A) Machine learning: The intention of ML is to enable machines to learn by themselves using the provided data and make accurate predictions. *Example:* "ok google" and "SIRI"

(B) Deep learning: Just like we use our brains to identify patterns and classify various types of information, deep learning algorithms can be taught to accomplish the same tasks for machines. DL algorithms are roughly inspired by the information processing patterns found in the human brain. *Example:* humanoid robots.

Now that the crux of artificial intelligence is deciphered, lets discuss about how artificial intelligence is helping or could help the fashion industry, and who would benefit and forfeit from it.

AI Stylist: Personal stylists are expensive and cannot always be around, so there is a potentiality of AI computerized stylist to be the future of styling. There are copious benefits of having a computerized stylist.

For example, they can process large amounts of data faster when learning about the users' style and memorizing the users' feedback. AI programs can also store descriptions of users' items and help users be more organized and efficient.

Uniqlo is coming close to full automation at its flagship warehouse in Tokyo. According to reports, Uniqlo's parent company fast retailing, has partnered with a Japanese start up that develops industrial robots to create two armed robots that is able to pick up t shirts and box these up a task that could be previously only done by6 human. This is an important innovation as it could enable this factory which has already replaced 90% of its workers with robots to roll out a fully automated process.

The role AI is playing at retail level for fashion shoppers:

Amazon- Amazon is coming with a virtual fitting room app which is in its early stages of patenting which would allow the users to try on outfits before buying them. The

users will be required to use pictures in the gallery of their phones to create augmented reality image of themselves wearing outfits that are on sale. The shoppers could swipe to their either like or dislike the pieces of clothing shown, and also use search terms like "search my look", "randomize", or "more like this".

BlinQ- New York - Singapore-based fashion technology start-up BlinQ plans to make their augmented reality fitting rooms a go-to teach in the south Asian luxury e-commerce market. Bob Chua, BlinQ's founder explained "BlinQ uses AR and Algorithmic patterns to provide users with the latest trends and personalised fittings from their digital devices. It also allows users to choose how they would like to devour fashion, which may not necessarily be to buy, but to also rent, subscribe, or pay later for latest luxury designs from major and upcoming brands across South-East Asia".

A Gentleman's tale is a Singapore mobile tailor company, which opened in April, 2019. They unveiled their mobile showroom bus, which doubles up as an actual fitting room. After the customer is done deciding on fabrics and designs of the outfit needed, they adjourn to the back of the bus, where, they stand in the middle as they're scanned using infrared light from sensors located at the corners of the space.

The scanner measures 127 points of the body, which is then translated into a computer rendering that can be instantly seen on an iPad. The entire process takes all of two seconds. The accuracy is said to be at 98 percent, and 3D scanning helps to immediately see things that are invisible to the naked eye. It is much faster and accurate. The founders also pointed out that there are also advantages to getting your measurements from a tailor, because, as the tailors have experience, they can give allowance in the outfit according to a person's body shape and lifestyle.

Popular AI methods used previously include:

A Bayesian Network is a probabilistic model that represents variables and their conditional dependencies. They have been used to infer relationships between previous fashion trends and future trends.

Fuzzy logic is an approach that utilizes uncertainty and approximate reasoning. It represents truthfulness and falsehood with degrees and works closer to human brain because it outputs a straightforward like or dislike.

Knowledge-Based systems are programs that represent knowledge and solve complex problems by reasoning on how knowledge artifacts are related or not related. They are used to show the relationships between features in fashion styling.

Other AI techniques and Technological advancements like Decision trees, Genetic Algorithms, Artificial Neural Networks (ANNs) augmented reality, virtual reality, 3D visualization and 3D printing are being increasingly applied in a creative way in the fashion industry.

An Artificial Intelligence eye on your fashion: The tool, named Fashion++, uses visual recognition systems to analyse the colour, pattern, texture, and shape of garments in an image. It considers where edits will have the most impact. It then offers several alternative outfits to the user. Researchers trained Fashion++ using more than 10,000 images of outfits shared publicly on online sites for fashion enthusiasts. The researcher mixed images of fashionable outfits to create less-fashionable examples and trained the system on what not to wear. But, as in any AI system, bias can slide through the data sets for Fashion++. The researchers point out that vintage looks are harder to recognize as stylish because training images came from the internet, that has been widely used only since the 1990s. Another challenge was that, most of the 'in fashion' clothes found on the internet were on models, but bodies come in a plethora of shapes and sizes which affected the fashion choices of the AI. However, the researchers are now working towards letting the AI learn what compliments different body types so that its recommendations become more adaptable.

Artificial intelligence in textiles: The adoption of AI applications in the textiles manufacturing industry is still very early, and although there are a few use cases, there doesn't appear to be widespread adoption of AI – even in developed countries. Below, are some of the AI applications in use currently.

Cognex – Fabric Pattern Inspection

Cognex Corp. is an American manufacturer of machine vision systems, software, and sensors. Cognex claims that its purported machine vision, Cognex ViDi platform can automatically inspect aspects of fabric patterns such as weaving, knitting, braiding, finishing, and printing. The company also suggests its platform requires no

development period for integrating it into a manufacturing system, and it can be trained using predefined images of what a good fabric sample looks like. With this machine vision,

HOW IT WORKS (reference added in the end)

Textile manufacturers might save on cost and time taken for inspecting the quality of the final fabric by replacing manual visual inspection with use the Cognex Vidi platform. Basically, the manufacturer can install the camera-based inspection system in their factories and input a several images of "good" final samples, and "bad" samples. The platform learns the weaving pattern, yarn properties, colours and tolerable imperfections from these images and after a training period could potentially be able to detect defects (like wrong knitting patterns) in the end-product.

Datacolor – AI Tolerancing for Fabric Colour Matching

Datacolor, founded in Lucerne, Switzerland offers colour management instruments and software. In the Industry, to ensure that the original design colours match the colours in a finished textile product businesses usually assign a limit called colour tolerance to determine how big the difference in colour between a sample and the requirements of the customer can be, before the sample is considered admissible.

Traditionally colour tolerancing was done based on numeric descriptions of colour through "instrumental tolerancing systems", which generally had a lot of false positives, which caused delays in the approval process because there was careful human intervention required.

Datacolor claims it has developed an artificial intelligence Pass/Fail feature to help improve the accuracy and efficiency of instrumental tolerance. In the Datacolor's AI procedure, the textile expert first visually reviews all the individual batches that had been manufactured. The operators enter the colour measurements and tolerances for all the batches in the Datacolor software to help train the system. The AI P/F system can then be tested for new batches to automatically set AI tolerances, training the system to determine which samples pass and fail the colour accuracy.

In conclusion, it should be noted that, while artificial intelligence is succouring the fashion industry to be faster and more precise with their sales or final products, the fact that fashion industry has always been a labour-intensive industry cannot be ignored. Thus, if artificial intelligence does take over, it will result in a major chunk of people losing their jobs. This portion of people will majorly include daily wage workers. That being said, Artificial intelligence in fashion is still in its introduction phase and has a long way to go before fashion can become a fully AI based industry.

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TECHNICAL SESSION II
FASHION AND TEXTILES: AN APPROACH TOWARDS SUSTAINABLE FUTURE

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Futuristic Trends for Sustainable Fashion: Innovations in Material, Technology and Concepts

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ABSTRACT

Textile industry is considered as one of the most polluting industry having inconsiderate effect on environment and human health. Today, the industry is facing many criticisms due to huge amount of water consumption, energy consumption, depletion of natural resources, creating huge amount of wastage and landfills as well as hazardous nature of various chemicals being used throughout from raw material extraction till disposal phase. But over the past few years, due to stringent environmental norms and increasingly consumer awareness, the use of sustainable materials and technology is taking off. Some of the innovative sustainable materials from food wastes like orange, grapes, pineapple, milk etc are being turned into wearable commodities as well as fabrics made from organisms by melding biology and fashion etc. are also being evolved out. The sustainable technologies like Air Dye technology, Digital printing, water free stone washing, bio-filtering waste water are getting momentum which saves water, energy and minimize the textile waste. Recycled synthetics made from plastic bags and bottles are also finding its way into fabrics. Some other innovative sustainable solutions by companies like 'Unlimited Rental Runaway' and 'Mud Jeans' which offers its customers to pay a monthly rental fee to rent their product, are also being appreciated. So the article provides a pluralistic view of sustainable ideas including materials, technologies and solutions.

Keywords: sustainable trends, innovations, fashion, natural, recycle, fruit fibres, QMilch

1. INTRODUCTION

Textile industry is considered as one of the most polluting industry having inconsiderate effect on environment and human health. Today, the industry is facing many criticisms due to huge amount of water consumption, energy consumption, depletion of natural resources, creating huge amount of wastage and landfills as well as hazardous nature of various chemicals being used throughout from raw material extraction till disposal phase **[Pal, 2017]**. Even growing a traditional natural fiber like cotton can cause enormous footprints. It can take more than 20,000 liters of water to grow enough cotton for a single pair of jeans, and cotton also uses more insecticides than any other crop in the world **[Peters, 2016].** The negative impacts of fashion industry can simply be assessed by looking at the rivers in China and Bangladesh that bear the colour of next season's clothing due to improper dye disposal **[Bauck, 2017].** But over the past few years, due to stringent environmental norms and increasingly consumer awareness, the use of sustainable materials, technology and practices is taking off to promote the sustainable fashion. Sustainable fashion is a part of the growing design philosophy and trend of sustainability, the goal of which is to create a system which can be supported indefinitely in terms of human impact on the environment and social responsibility **[www.wikipedia.org].** A myriad of fashion forward innovations that combine green practices are infiltrating the fashion world **[Friedman, 2015].** The article attempts to provide some of the groundbreaking technologies happening all over the world over the last few years along with sustainable materials and innovative practices which are gaining momentum.

2. SUSTAINABLE TRENDS

There are significant material values at the end of a product's life whether it is natural or manmade which is currently being wasted causing depletion of resources. These values must be captured in a judicious way to make use of the material in sustainable way **[Trend Report, 2016]**. Here are the glimpses of some of the innovations happening to capture the embedded value in our food products:

2.1 Turning food waste into resources

A working prototype is being developed that turns citrus byproducts like wasted peels and seeds into raw material

that can be spun into yarn **[Peters, 2016]**. The innovator of converting orange byproducts into a yarn has received Global Change Award 2015 sponsored by H&M. The yarn produced from the by-products can be used to create different types of textiles, from making dresses to shirts or scarves **[Trend Report, 2016]**.

Another prototype, which converts the grape waste collected from wine production into new type of vegetable leather, is also in progress. With this innovation, instead of burning the leftovers from winemaking, which creates carbon dioxide, it becomes raw material in a process that doesn't need any harmful chemicals and a new type of leather is produced without the bad stuff **[Trend Report, 2016].**

Anke Domaske, a microbiologist and fashion designer discovered an eco-friendly way of turning the milk into high end fashion fabric 'QMilch' having silk like feel and is non-allergenic. The milk is allowed to ferment before it is turned into a powder, which is then heated and mixed with other natural ingredients. The entire mixture is turned into yarn, which can be woven or knitted. According to Domaske, the process only uses two liters of water to create one kg of material, compared to the 20,000 liters of water to produce one kg of cotton **[www.qmilkfiber.eu, www.theadairgroup.com].**

Taiwanese textile company Singtex's technology combines the post-patented processed coffee ground with polymer to create master batches before spinning it into yarn. Fabrics made out of coffee ground fibres like S.Café by Singtex offer excellent natural anti-odour qualities, UV ray protection and a quick drying time **[Preuss, 2017].**

2.2 Clothes made from organisms

Suzanne Lee has come up with an innovative way of creating Bio couture, growing textiles by melding biology and fashion. The researcher has used bacterial cellulose grown out of organisms like bacteria, yeast, fungi and algae. Biocouture clothes and shoes produced in this way are not only biodegradable but can be composted and discarded in the same way as vegetable peelings [**Cortwright, 2016; Friedman, 2015**]. There are also other biocouture products which are made exclusively from green tea, sugar and microbes.

Another innovative way of producing leather is done by Modern Meadow, a company which is "growing" leather in a lab using yeast fermentation to produce collagen**.** Leather has been in question due to its large emission footprint and the toxic chemicals involved in tanning as well as by animal right activists **[Bauck, 2017]**. So this method may be helpful for the leather industry in producing leather in a sustainable way.

A startup has also started working on an open-source process for turning algae into fabric. This Quick-growing algae, which doesn't require extra water besides the oceans and lakes it grows in, may be a sustainable source of producing textiles if comes into commercial reality **[Peters, 2016]**.

The New York based biomaterials research group has developed a yarn made of biopolymers extracted from kelp. The material produced is durable and biodegradable **[Bauck, 2017].**

2.3 Innovations in recycling

Society throws away 200 billions plastic bottles a year and it takes nearly 500 years to decompose a plastic bottles, so attempts are being made all over the world to recycle the plastic bottles and blend it with polyester and cotton to create textiles **[Breyer, 2012 ; Cortwright, 2016].**

Hong Kong Research Institute of Textiles and Apparel (HKRITA) has successfully developed a method for separating out the cotton and polyester in poly-cotton blends that would allow both materials to then be recycled into new yarns. The process uses heat, minimal amounts of water and less than 5 percent biodegradable green chemical to separate the fibers. The polyester, in particular, experiences no quality loss as a result of the process **[Bauck, 2017].**

In another innovation, wherein a new type of microbe has been found which can break down the polyester into a basic raw material which can further be used by polyester manufacturers. In this way the polyester which is hard to recycle is recreated without losing its quality. The process also works on blend materials, like cotton and polyester **[Peters, 2016].**

For cotton which is hard to recycle and is generally shredded up for insulation, an innovative new process uses an environmentally friendly solvent to dissolve old

cotton clothing into a cotton-like material that can be spun into new fibers–eliminating both waste and the problems that come with growing new cotton **[Peters, 2016]**

Upcycling is also getting momentum in an attempt to produce sustainable fashion. Upcycling is an approach to transform by-products, waste or disused materials or products into something new of better quality and greater value. By upcycling, energy, water, chemicals and other required resources are saved **[www.futurelearn.com]**

2.4 Innovations in Technology

Bio-Filtering Wastewater: The comprehensive technology known as Sequencing Batch Biofilter Granular Reactor helps in removing the most toxic textile dyes components - the recalcitrant organic compounds - by breaking them down via ozone treatment. In this treatment, microorganisms, which are grown in aggregates, process the pollutants of the waste water. Each aggregate holds up to 10 times more microorganisms and produces 80 percent less sludge than conventional biological filters [Breyer, 2012].

AirDye technology: The technology developed by Colorep in California, is a water-free dyeing and printing on textiles solving water pollution, save energy and produces no harmful by products. The technology works with proprietary dyes that are heat transferred from paper to fabric in a one step process **[Breyer, 2012; Cortwright, 2016]**

Water-Free Stone Washing is also being used by Levi's in an attempt to reduce water footprint. Levi's Water Less products are water-conserving collection that allows the company to use an average of 28 percent less, and at times as much as 96 percent less water to finish their jeans **[Breyer, 2012]**.

Chieza, a biodesigner has tried to develop bacteria-dyed clothing using bacteria-secreted pigment to dye a fabric. The technique dramatically reduces water usage, requiring less than seven ounces of water to dye a one-pound piece of silk, and the pigment itself is naturally and non-toxically created by the bacteria **[Bauck, 2017].**

Direct Panel on Loom (DPOL) technology: DPOL technology was created by Indian designer Siddhartha Upadhyaya. It may increase the fabric efficiency by 15 percent and reduce lead-time by 50 percent. Technique involves using a computer interfaced to a loom and data such as color, pattern and size related to the garment is entered, and the loom cranks out the exact pieces -- which then just need to be constructed. Weaving, fabric cutting, and patterning happen all at once. DPOL also helps in saving energy and water [Breyer, 2012].

2.5 Sustainable design techniques [www.futurelearn.com]

There are a number of techniques, strategies, alternative processes and approaches that can be adopted to design products that have a low environmental impact and positive social purpose. Some of these are briefed below:

Zero waste pattern cutting: Zero-waste is a design technique that eliminates textile waste at the design stage. It has been estimated that 15% of textiles intended for clothing ends up on the cutting room floor. The zero-waste approach means to work out the pattern pieces on to the textile dimensions like a jigsaw puzzle that it result out into no waste.

Minimal seam construction*:* This is a design technique that reduces the number of seams required to sew together a garment. It makes manufacturing much quicker and can save on materials. It can also allow the garment to have greater freedom of movement and increase comfort for the wearer. Some companies, like The North Face, are investing in technology that can fuse seams together, meaning no sewing required.

Design for disassembly: With this strategy, Products are designed in such a way that components can easily be taken apart at the end of the product's life and can be repaired, reused or recycled. It will help in saving costs and product's environmental footprint.

Multi-functional / transformational*:* This strategy means designing products for multiple uses. i.e garment can be worn multiple ways or something that is reversible or has components that you can add or edit.

Design for longevity: There are many reasons that people discard clothing - not the right fit, the person changes size, the fabric quality deteriorations or the style becomes outdated. So even the smallest design choices can impact how long a product's life will last. So avoiding the products from going to landfill is by designing to last, to be cared for and repaired, to be

reused or to be passed on to others. Emphasis can be on classic and timeless styles, colours, using high quality fabrics that can withstand use and care, educating customers about how to best care for the product.

Craft preservation: Craft preservation reflects our values and responsibility towards social sustainability and helps in passing the social benefits to our artisans. Ancestral craft techniques can be preserved by incorporating them into modern designs.

2.6 Sustainable Innovative Concepts

Looking at the vast amount of waste generated through used up garments and causing landfills, some of the companies like 'Nudies Jeans and 'Rental Runaway' offers their products like Jeans, and fashion accessories like handbags, sunglasses etc. for a monthly/annual rental, thus paving a way for innovative strategies and solutions for sustainable business models **[Cortwright, 2016]**.

2.7 Promising sustainable fibres in fashion [Preuss, 2017]

Hemp fibres: Hemp is one of the promising sustainable natural fiber which consume very little water and does not require herbicides, pesticides, synthetic fertilizers or GMO seeds. Hemp fibres are antibacterial, durable and resilient, and work as a natural air-conditioning system. One of the contradiction this plant (Cannabis Sativa) has been associated is its connection with recreational drugs because of which the cultivation has been severely hampered, especially in the western world. The situation is different in China, where the industrial use of the cannabis plant was never prohibited. Thus, China currently accounts for more than 50 percent of the global hemp production and holds more than half of the more than 600 international patents on hemp fibers and textile production.

Stinging nettle fibres: The common stinging nettle, *Urtica dioica*, fibres are versatile and weather friendly both in winter and summer. They require less water and pesticides than cotton. Nettles are harvested in summer and the stalks are dried well and broken to separate the woody parts. Then, the plant is hackled to separate the fibers and to remove the leaf attachments. After that, the fibers are spun wet and then dried. Twisting those increases tear resistance. Nettle fibres are strong and flexible and have a good spinning length.

Pineapple fibres: London-based Ananas Anam has developed a natural and non-woven textile out of pineapple leaves, known as Piñatex which is remarkably similar to leather. Decortication process extracts the fibres from the leaves. The fibres then undergo an industrial process to become a nonwoven textile, which is the base of Piñatex. A by-product derived from the manufacturing process is biomass, which is converted into organic fertilizer or bio-gas and used by the farming communities, thereby closing the loop of the material's production. Piñatex is also a strong, yet versatile, breathable, soft and flexible, material which can be easily printed on, stitched and cut, making it suitable for a number of fashion products.

Banana fibres: Banana fiber is one of the world's strongest natural fibres. It is made from the stem of the banana tree and is incredibly durable and biodegradable. The fiber consists of thick-walled cell tissue, bonded together by natural gums and is mainly composed of cellulose, hemicelluloses and lignin. Banana fiber is similar to natural bamboo fiber, but its spin ability, fineness and tensile strength are said to be better. Banana fiber can be used to make a number of different textiles with different weights and thicknesses, based on what part of the banana stem the fiber was extracted from. Banana fibres can be used to make ropes, mats, woven fabrics as well as handmade papers. Green Banana Paper, a company based on the island of Kosrae in Micronesia, is using banana fiber to make vegan wallets, purses, beads and paper.

Lotus fibres*:* The biggest hurdle is the complicated and lengthy manufacturing process involved in using lotus stems. However lotus fibres produces a luxurious fabric that feels like a mixture of silk and raw linen that is also stain-resistant, light weight, soft and silky.

Hemp, Banana and Nettles fibres have huge potential for the mass market whereas fabrics made out of lotus stems and pineapple should be interesting for the luxury market.

3. CHALLENGES

Inspite of all innovations whether it is technological up gradation, inventing new sustainable materials, innovative strategies or solution, the reality is that the textile and fashion industry still has to adopt the sustainable approaches effectively. The sustainable alternatives are facing difficulty at implementation and

distribution stages. Recycling in textile industry, whether it is effluent treatments, waste materials or used clothing recyclability, is still a challenging task ahead and has numerous constraints related to proper utilization.

4. CONCLUSION

Textile Industry has impacted a lot to the environment and human health. Ecological issues are becoming important. Regulations are being enforced to curb the negative impact which the textile industry has done to the society. Though modern research has helped in developing technology to reduce the overall impact to some extent, yet the industry has to take the lead and there is a long way to go. There is need to spread awareness campaign among consumers to look for sustainable products which has been manufactured with the highest environmental standards, and maintaining sustainability throughout its life cycle. In future, how a product is made will be of growing importance in the decision to purchase.

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Barriers and Challenges to Adoption of Sustainability in Textile and Apparel Industry in India

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ABSTRACT

There seems to be not much clarity on the future perspective of sustainability in the fashion sector although sustainability narrative has been receiving much attention from the consumers and well as the business and policy sphere. A research carried out by Boston Consulting Group and Global Fashion Agenda for the Copenhagen Fashion Summit in 2017, indicates that the sustainability 'pulse' of the apparel industry is weak. The fashion industry scored 32 out of 100 according to a scoring system to measure the sustainability, showing it is 'not yet where it could and should be(Globalfashionagenda.com, 2020). By 2030 global apparel consumption is projected to rise by 63%, from 62 million tons today to 102 million tons which is equivalent to more than 500 billion additional T-shirts, adding further pressure on the industry to move towards circular economy. Although sustainability has been gaining traction in India and worldwide and both the millennial and the Gen Z are adopting sustainability in their consumption, however there seems to be several barrier to adopting sustainability in Indian textile and apparel industry. This paper attempts to explore the reasons or challenges faced by the Indian industry in adopting sustainability and make environmental and social factors guiding principles for their companies' strategy. The important barriers have been identified through literature review and questionnaire survey and semi –structured interviews with experts across the apparel and textile value chain.

Keywords: Sustainability, Value chain, Challenges, Barriers, Circular Economy.

1. INTRODUCTION

Being the world's second-largest polluting industries, textiles and apparel industry has a central role in the global discussion on climate impact, chemical pollution, water shortage, and human rights. While implementing sustainability is critical to this industry, it is hugely challenging because of its long and complex global supply chain networks, as well as the stress for achieving low cost and shorter lead time. There are several stakeholders responsible in this process of production and consumption which include consumers, activists, government, policymakers, business, media and all other actors across the borders. Thus, finding appropriate solutions require innovative thinking and efforts on both the supply and demand side at multiple societal and governmental levels. Companies now need to adopt the triple bottom line approach and focus not only on financial performance but also should consider social and environmental performances in their global business operations. Sustainability seems to be gaining traction with the Millennial and Generation Z] (Albouy and Adesida, 2018). As per a survey by the Cotton Council International and Cotton Incorporated Global Environment Survey, consumer priority for sustainability is high in countries such as India (81 percent), Mexico (69 percent), Italy (62 percent), and China (60 percent) (Albouy and Adesida, 2018). However, there seem to be several barriers to adopting sustainability both by the consumers and industry in India.

2. LITERATURE REVIEW

2.1 Barriers for the Industry

The global network of the supply chain in the apparel and textile industry creates extra challenges both on the demand and the supply side. On the supply side, due to the involvement of various stakeholders and international context, there are considerable governance challenges. On the demand side, consumers have zero understanding of textile and clothing production contexts. So far sustainability has been considered by the industry's incumbents to be nothing but a source of overheads and has been implemented only to meet regulations, uphold a brand image, and match the

competition (Albouy and Adesida, 2018).When choosing to implement sustainable initiatives, an incumbent tends to face the following challenges. 1. A long-term commitment to sustainable fashion principles which will involve finance, human resource and time investment. 2. A substantial hit on their margin earning, necessitating the adoption of new business models and services 3. Existing corporate governance strategy needs to be reviewed to factor in success measures on sustainability and favor long-term sustainability initiatives (Albouy and Adesida, 2018). Finally, the biggest challenge for all is the transparency of their supply chain.

2.2 Barriers to Consumers

Since clothing choices are motivated by peoples need for identity (Max-Neef, 1992) and esteem (Maslow, 1943)the attractiveness of fast fashion as part of personal good appearance, social status, and social identity creates several barriers for more sustainable clothing and textile shopping habits among consumers. Various social and market pressures act as barriers and consumers need help to change their fashion consuming habits. The barriers can be categorized as internal or external (Harris, Roby and Dibb, 2015). Internal barriers include a lack of concern for the environment, limited understanding about clothing consumption's impact on the environment, negative attitudes towards sustainable clothing. Internal barriers also include characteristics, such as age and education, motivation and value system, lack of knowledge of different fibers and their impact, wrong perceptions of sustainable clothing as less stylish, less well-fitting and less comfortable. External barriers included the price of sustainable clothing, a lack of infrastructure also socio-cultural norms, limited availability of sustainable clothing outlets; limited styles, sizes and fit; lack of financial resources to buy more expensive sustainable clothing; poor presentation of clothing in second-hand shops; and social expectations regarding set conventions of dressing (Harris, Roby and Dibb, 2015). This indicates that interventions are needed at the level of individual consumers, society, and industry and policymakers.

Methodology: Semi-structured interviews were conducted with a variety of experts in the field of retail, manufacturing, FMCG, educationist, designers, e-tailers, exporter, corporate, consultant and consumers to capture a range of stakeholder perspectives and integrated with a literature review to validate the study. An exploratory research method was adopted to capture perspectives, experiences, and insights of individual participants on various issues. Purposive sampling was used to identify key respondents (Harris, Roby and Dibb, 2015). These consisted of five experts from retail, one specialist consultants and one exporter, one researcher, one designer cum consumer, one kid's brand manufacturer. All had expertise or exposure to sustainable fashion. Key informants of the respondents are tabulated in Table 1.The important barriers and challenges to adopting sustainable clothing, industry awareness, the roles of various stakeholders, and consumer awareness and attitudes were addressed. Measures taken to increase sustainability were also considered, as was the role of Government policy, regulation and legislation. The interview guide is tabulated in the appendix. The quotations used to illustrate the findings are anonymized and categorized by type of key respondent, with a number assigned to each participant type to signify separate contributions (Harris, Roby and Dibb, 2015).

3. FINDINGS AND DISCUSSION

1. **Awareness of Industry:** All respondents agreed that the industry stakeholders are very well aware of the sustainability factors and SDG goals chattered by the UN. However, the consciousness for sustainability was missing among the manufacturers. One respondent said the manufacturer's mindset needs to change.

2. **Barriers for adoption by Manufacturers:** All respondents were unanimous about the main barriers to adopting sustainability by the clothing and textile industry. The topmost being the increased cost which comes with making sustainable products or adopting sustainable processes. (Retailer 1, 2,3,4,5 and Manufacturer). Lack of demand-pull due to low consumer awareness cum consciousness for sustainable products is the second most important barrier according to all. (Retailer 1,2).The bad state of the economy, where retail inflation is touching 7%, the government's lack of priority and willingness to support in form of any policy or mandate or aid or incentive is a big dampener (Retailer 1,2,4). "Industry body like CMAI or RAI is also highly fractured and lack specific goals for sustainability which results in lack of ecosystem and technology development". (Retailer2). Population density is another huge problem and barrier in India (Retailer

4). "*No cohesive communication on sustainability seems to be there which could trickle down to the stakeholders or consumers. Lakme Fashion Week as a platform defines sustainability weakly*". (Corporate). "*Depending on what stage of growth the organization is in that manufacturers will adopt sustainability"* (Retailer 5). "*A lot of livelihoods can get affected hence government is unwilling to stake stringent action"*. (Retailer 5)

3. **The barrier for adoption by Retailers: "***Indian retailers are not concerned because they are struggling with barely 2/3% PAT and zero to negative growth because of disruption by the online platforms*" (Retailer 1). Businesses have become economically unsustainable. They are stuck in the day to day business concerns hence they do not incline to invest in sustainability. "*It's a matter of survival first*." (Retailer 1, 2). Upgrading incurs large cost. (Retailer 2) Value retailers are thriving in India and no one is ready to pay the upcharge. (Retailer 1, 2, 3).

4 **Barriers for adoption by exporter**: Indian exporters are not only aware but largely adopting sustainability as there is a demand-pull from foreign buyers and consumers. They are using recycled polyester and organic cotton however it is limited to the yarn stage. The % of sustainability claimed is dependent on their clients abroad. However, no one yet is talking about 100% sustainable as it's next to impossible (Exporter). The awareness about sustainability and adoption is higher than the retail counterparts. The biggest barrier is uncertainties of certifications as well as expensive certification which can act as a deterrent to adoption of sustainability. (Textile Trader)

5. **Interventions proposed:** The Indian clothing industry needs to have stricter norms for sustainability across the value chain. Government intervention is critical. "*Government should mandate every retailer or manufacturer should meet a certain % of sustainability in a year"* (Designer). Similar to the step taken by the Government on plastic ban, dry and wet waste garbage segregation, some policy measures in the fashion industry too is required to create any considerable impact (Retailer 4). Intervention in terms of cartelization could help drive sustainability among manufacturers as they are assured about the sales (Retailer 2). "*Make in India initiative can be tied up with sustainability*" (Retailer 1). "*The government should incentivize or give subsidy or benefits similar to ones given to auto industry for electric cars"*. (Retailer 3). "*The government should rather give incentives to develop technology and subsidize research*". (Retailer 5). The government can have some packaging collection centers and certification for compliance. (Retailer 4)

6. **Customer Awareness**

The Indian consumer mindset has not evolved vis-à-vis their western counterparts as unless basic needs are satisfied, no one is bothered about sustainability. (Retailer 1, 2, 4). "*In Western economies the per capita GDP is high, and consumers can afford to pay high prices*". (Retailer 1). Awareness about sustainability among Indian consumers is poor and consumers don't see the value. General consumers are not matured enough. Retailer4 questioned how many recycled shoes of Adidas would one buy? The new generation of consumers is conscious and aware as validated by the literature review. "*Sustainability concerns are as of now among the SEC A A+ customers who are buying brands like Nicobar and Good Earth*". (Retailer 4)"*With retail inflation at 7% discretionary income of consumers is going to other things. Hence people are moving to cheap fashion*." (Retailer 4)

4. PROPOSED INTERVENTIONS

1. Reduced cost focus: Just like in branded clothing, by highlighting the other benefits that increase the value of the clothing in terms of quality and style, manufacturers can distract the focus on cost. Further investigations are needed to validate the effects of such interventions. (Harris, Roby and Dibb, 2015)

2. Mainstreaming sustainable clothing: a Main barrier for customers to prefer sustainable fashion is they perceive them to be less stylish and limited by choice. "Unfortunately, people still perceive sustainable clothing as not looking fashionable" (Designer) "The primary purchase motivation is to look good and not whether it's a green product." (Designer). "The product has to have the right fit,

hand feel, and color, and one needs to feel good about it". (Designer). Sustainable clothing designs need to normalize. (Harris, Roby and Dibb, 2015)

3. Educating the consumers: Most consumers are unaware of the complexities of the clothing production and supply chain. "Platforms like Lakme Fashion week define it loosely". (Corporate). More media interventions and social marketing campaigns can educate the consumer about sustainability to induce buying.

4. Skepticism: Consumers are unwilling to pay more for products claiming to be green and doubt the veracity of their claim as 'green washing' is quite prevalent. Improving the transparency of the supply chain can help gain trust and engage effectively with consumers. (Academic) Both academics and retailers highlight the importance of trust. (Harris, Roby and Dibb, 2015)

5. Changing consumers' habits: There are challenges in changing consumers' habits as well as their mindsets. "There is very little scope in bringing in sustainability in Bridal wear." (Designer) Social norms represent a major barrier to changing behavior An intervention to change consumers' clothing disposal habits that were proposed was upcycling and repurposing to prolong the life of clothes (Designer).

6. Upcycling: Just like paper, glass and plastics are recycled, clothing and textile recycling can also happen with the right incentives from government and markets for recycled products. Monthly doorstep textile collections can happen by the Municipal authorities who would also help them to reduce, recycle and upcycle.

5. CONCLUSION

The research reveals that it's difficult to change consumers' and manufacturer's mindsets for these reasons: (i) Clothing sustainability is complex to understand; (ii) consumers concerns are diverse; (iii) No company, institution or individual alone can address the economic, environmental, social and technological challenges of a complex, interdependent world.(Harris, Roby and Dibb, 2015), (Davos 2020) and (iv) Intervention of the Government is a critical factor for the adoption of sustainability whether social or environmental. (Majumdar and Sinha, 2018). These interventions range from removing focus from cost, design normalization, incentivizing industry and increasing the ease of purchase, to increasing upcycling, recycling and repair]. (Majumdar and Sinha, 2018). The most important barrier which emerged is economic reasons. The movement towards sustainability in India is happening although the pace is debatable. Pressure of climate change and scarcity of resources are the two most important drivers for all stakeholders to adopt sustainability.

TABLE 1: Key respondent characteristics

Interviewee type	Expertise	Organization Type
Retailer 1	Group CEO	Kaya Limited
Retailer 2	Country Head, Corporate sales and alliances	Breigns India (Kalyan Jewellers)
Retailer 3	COO	Lacoste India
Retailer 4	CMO	Bata India Ltd.
Online Retailer 5	Senior V.P, Apparels, Beauty, Home	Myntra Fashions
Exporter	Director	Malhar Exports
Brand manufacturer	Proprietor	Soul Fairy Apparels
Textile traders	Chairman and MD	Texpert India Pvt Ltd.
Academician / Designer	Proprietor / HOD Fashion	Jules Brides /WWI
Corporate	Executive Director Hindustan Unilever Ltd. & Vice President Personal Care - South Asia	HUL

TABLE 2: Interview questions

Main interview topic	Questions
Progress and priorities in sustainable clothing	□ What are the biggest challenges? □ What do you see as the main barriers?
Awareness Industry	□ How aware are the different stakeholders of sustainability issues? □ To what extent does the industry perceive there is a need to improve the sustainability of clothing? □ How aware are retailers/ manufacturers of methods to make clothing more sustainable?
Awareness consumers	□ How are consumer attitudes to fashion changing and are they likely to change in the future? □ How well defined is the distinction between ethical and sustainable clothing in consumers' minds? □ Which customers (segments) are most interested? □ To what extent will consumers pay more for ethical/sustainable items? □ Are there any obvious barriers for consumers to buy sustainable fashion? □ Is there any evidence of the life cycle of clothing changing? E.g. more re-cycling, less washing.
What options are considered when trying to increase sustainability	□ Materials? Transport? Local production? Packaging? Production? Finishing/chemical treatment? Retailing? Design quality? End of life?
What are the main motivations to develop sustainable/ethical clothing?	□ Regulation? Consumer pressure? Reputation/CSR? Cost savings?
Public policy	□ What role do you think public policy could play in increasing sustainability? □ Would you welcome legislation/fiscal incentives.

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Greener Ways to Color Textiles - Air Dyeing Technology

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ABSTRACT

The water is an essential resource for life on the planet and for human development. The textile industry is one of the anthropogenic activities that most consume water and pollute water bodies. Conventional dyeing technology which uses vat dyes and reactive dyes requires large quantities of water and generates high effluent load. To reduce these water contaminations, a new technology called as "Air-Dye" has been introduced. This new emerging technology of dyeing is really enthusiastic for textile industries and has reached the international advanced level and has met the state emission-reduction and energy-saving requirements for environment-protection products. Air Dyeing is a process that completely replaces the traditional dyeing process that was intensely water-dependent. Air-Dye technology manages the application of color to textiles without the use of water. It is today's sustainable alternative to traditional dyeing and decorating processes.

Keywords: development, sustainable, massive, respiratory, eco-system, global warming

1. INTRODUCTION

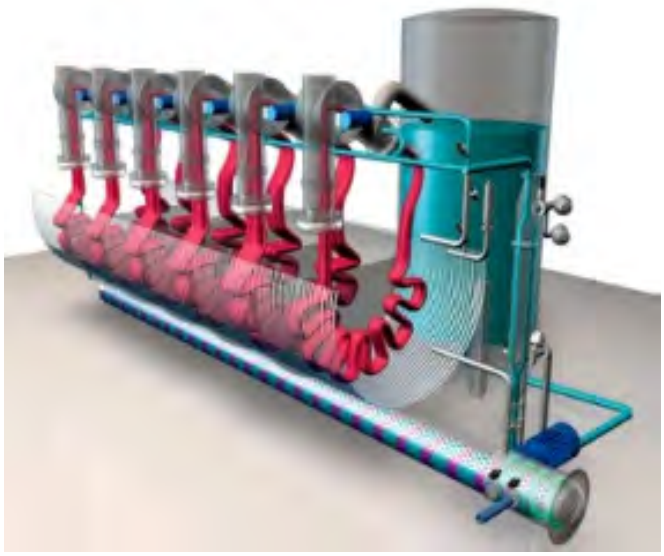
When buying a new outfit, most people don't consider the process that went into tinting that vivid colorfully patterned dress. But dyeing clothes requires massive amounts of water, energy and chemicals. So companies are working on new ways to color textiles that are both environmentally friendly and cost-effective.

In addition to being resource-intensive, textile dyeing often dumps large quantities of chemicals into wastewater from mills and dye houses. These substances can turn rivers startling colors and may also affect human health. Due to the toxicity of the dyes and chemicals used in textiles and inappropriate discharge of such waste has led to skin diseases and respiratory problems among many workers. This has given an impetus to the rising demand for producing textile products through environment friendly and sustainable dyes and processes.

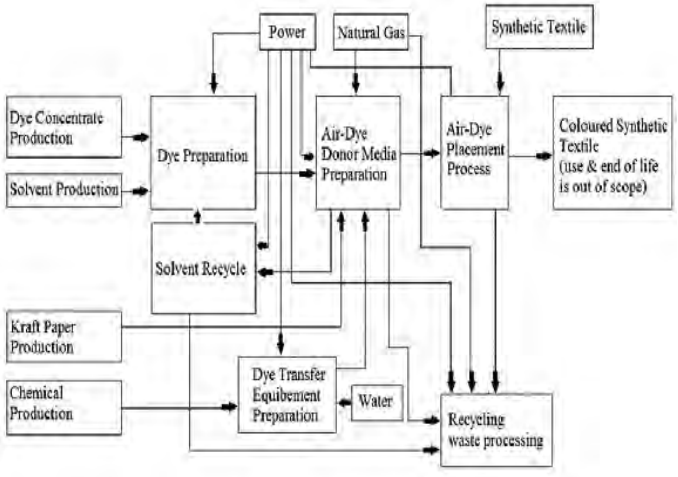
The dyeing and finishing processes in the textile industry have garnered a lot of attention lately because of the emerging concept of sustainability and eco-friendly textiles and garments. Under the conventional dyeing process, sizeable quantities of chemicals are needed for ensuring proper dyeing of the fabric and subsequently these chemicals find their way into the lakes, rivers and seas of the region. At the same time, vast amounts of water are consumed during the dyeing process by the textile industry. Both these factors cause substantial damage to the eco-system of the region. Air Dyeing is a revolutionary method of dyeing that causes minimum harm to the environment.

Air dyeing uses zero water and manages the application of color to textiles without the use of water. It is a super energy-efficient process that is now slowly being adopted by the textile industry. Air dyeing uses a spray-type technique to impart the colour to the fabric, without any use of water. Therefore there is also no waste water that needs to be disposed off into the environment. AirDye technology uses up to 95% less water, and up to 86% less energy, contributing 84% less to global warming. It is estimated that up to 45 gallons of water can be saved during the dyeing of just one garment simply by switching over to Air-dyeing technology. The

AirDye process employs air instead of water to help the dyes penetrate fibers, a process that uses no water and requires less energy than traditional methods of dyeing. Thus it is vital that more and more companies start adopting this technology. Water is one of the most precious resources that need to be conserved and preserved.



Airflow is the key element of the technology, as air is an ideal transport medium. The replacement of dye liquor with air as a method of transporting piece goods in jet-dyeing machines was a big step toward reducing water and chemicals consumption. Compared to the jet system in which the nozzles are filled with liquor, nozzle pressure is negligible, thus offering optimum protection of sensitive textile surfaces. At the same time, the use of the mass flow principle provides a major improvement in fabric hank laying, thus preventing creasing.



Main advantages are as follows:

- Eliminates water in the color application step and simplifies the process, creating revolutionary possibilities of new industry and employment in un-farmable, arid regions of the world.
- It does not pollute water in the color application process. By using air instead of water to convey dye, no hazardous waste is emitted and no water is wasted.
- Greatly reduces energy requirements, thereby lowering costs and satisfying the strictest standards of global responsibility.
- It does not use boilers, screen printing machines, drying ovens, or cleaning and scouring chemicals, thereby eliminating major sources of pollution.

2. APPLICATION

- **Promotional Items:** Banners, signage, short run branded products, tote bags, reusable bags.
- **Apparel:** Fabric for all types of garments, finished accessories – scarf, ties, aprons etc. specialty fabrics for custom items, flags, umbrellas, tents, uniforms – civic, corporate medical, swimwear, sarongs, outerwear, sportswear, yoga-wear, active-wear, dance-wear, infant, toddler apparel, junior apparel, missy apparel, women's wear, lingerie, sleep wear, accessories- handbags, cosmetic bags etc.
- **Interiors:** Carpet, ceiling tiles, drapes, curtains, blinds, top of bed product – coverlets, bedspreads etc., linens, wall covering, tabletop, napkins, shower curtains, pillows, mattress coverings, & upholstery – sofas, chairs, etc.
- **Industrial Print Applications:** Hard surface laminate, melamine, thin paper, vinyl transfer, &thermo films
- **Medical:** cubicle curtains, hospital gown

3. CONCLUSION

Today, textile dyes have become an integral aspect of every man's life and with every individual becoming more aware of his social responsibility towards the environment, the quest for superior and better dyes and

technology is on. 'Air-dyeing' technology is just one step in this direction. This technology eliminates hazardous wastewater as a byproduct of dyeing fabric. Water scarcity affects one in three people on every continent and is getting worse as water needs rise with population growth, urbanization and increased usage by households and industries.

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Knitted Footwear Technology – An Approach Towards Sustainability

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ABSTRACT

Manufacturing footwear is a multi-process task where a variety of operations are conducted sequentially to manufacture full footwear. At the time, shoes were made of bits of leather and other synthetic materials that were cut and sewn together, known as "upper," and then attached to hard soles. Much is still done by hand, given the use of machinery, with skilled workers required to bring the shoes together. The demand for leather shoes is also declining considerably due to environmental consciousness, resulting in a corresponding rise in demand for textile based shoes. Especially in the case of athletic footwear, the use of knit technology in upper making could transform the entire traditional shoemaking process. Athletic Footwear (Sport Shoes) accounts for about 36 per cent of all sales of footwear worldwide. A one-piece 3D upper is created by a CNC knitting machine, and then assembled with tongue, lining materials and reinforcements. The woven upper made from mainly recycled PET, creating a lightweight athletic shoe with a snug fit. It also uses an automated production process that reduces waste by weaving only what is required. The machines "knit" fibreglass fibres which could then be combined with a solvent to harden into a mould designed to match the foot of a person. The upper portion can be designed to interact with the foot anatomy; the fibres behave like tendons and enhance our foot movement. Shoe uppers can be made in a single knitted layer with all the functionalities required. A tighter weave can be built to provide more arch support to the foot by changing the knit density in different areas and a thinner, breathable weave to provide more air flow. The possibilities are endless, since everything that can be made into a yarn: oil, wool, kevlar, even gold and stainless steel. The goods can be made in one place from start to finish. Shoe knitting is an independent process, like 3D printing, which saves time, money and energy. This commonly used 3D knitting technique will improve the productivity of the industry by reducing material costs, labour-intensive costs and improving lead time for the fast fashion. With the implementation of this technology, 80% less waste can be generated. Results show that the production of knitted uppers have lower environmental impact than the traditional running shoes while considering the factors like global warming, acidification, toxicity and carcinogenic effects on human health.

Keywords: Footwear, Knitting, Sustainability, Environment, Fast-Fashion

1. INTRODUCTION

Automated 3D & 4D knitting technology have changed the way shoes are produced, lead to a reduction in production and inventory costs. The future of shoe making has been launched in the forms Fly-knit by Nike and Prime-knit by Adidas. The uppers of these are made from a single piece of fused yarn, a model of more sustainable and effective manufacturing, instead of leather or nylon like conventional materials.

With the old shoe-making process, excess material could not be reshaped or reused, creating a large amount of waste. But according to Nike's sustainability report, the production of knitted shoes results in 80 percent less waste. That's because when working with yarn, only an exact amount is used. Then, the thread is cut and the rest of the yarn can be used to make another shoe. The technique isn't limited to one type of fiber, rather anything that can be made into a yarn like carbon, wool, Kevlar, gold, stainless steel etc. can be used in this technology.

Both sustainability and simplicity are the two key features of this technology. This technology helps in reducing the solid wastes thus the material costs, labour costs, complexity of production and it's lead time, the uses of energy, etc which benefits both the consumer and the business. As the technology is sustainable that doesn't mean they aren't trendy in fashion. With this technology while companies concentrate more on sports footwear (Nikes with their running, football, soccer and basketball shoes), have started developing more casual shoes for daily life.

The knitted footwear provides a comfortable & lightweight fit, which is a long-standing demand from different sportspersons. As estimated by Nike, Fly-knit reduces footwear waste by 80%, means make up of 60% of the environmental impacts like water, soil, electricity, chemicals, emission of greenhouse gases, contaminants, solid waste etc. as compared to "traditional" shoes.

2. SILENT FEATURES

2.1. Flexible Design & Construction

In 2012, knitted footwear technology has changed the entire process of athletic shoes manufacturing. Once found only for costly shoes, now is rapidly expanding to lower-priced shoes too. Along with Nike, Adidas and Puma, in Chinese local market casual shoes are now being made with 4D knitting technology.

It is like growing a product rather than piecing it together. The designer could engineer the upper to work with the anatomy of the foot where the fibers behave like tendons and enhance the foot movement. Instead of cutting the shoe out of flat pieces of materials and joining them in shapes, this technology makes everything at one time. This opens up the possibilities to incorporate different kinds of thread and different levels of knitted thickness into a single shoe. A designer can also manipulate the knitting with the use of less thread in areas for more breathability and stretch.

To construct the one-piece upper, the knitting machine is loaded with polyester, nylon, or spandex fibers. The newest knitting machines can handle a mix of fibers and up to 10 colors at one time. The machine can be programmed to knit one upper at a time or 3 uppers with a maximum width of 90cm. Depending on the programming and fibers selected; the upper can be thin and stretchable or thick and stretch resistant. The design opportunities are nearly infinite with fiber options, colors choices, knit densities, and openings configurations. Although these shoes look like they are completely produced with knitting technology but the internal lining, reinforcement and padding are to be attached in the same way as it is found in conventional shoes.

2.2. Complete Automated Production

While 3D seamless knitting technology has eliminated cutting and sewing from production process, thus reducing labour and solid waste significantly but it is not yet fully automated. After a seamless shoe upper is knitted, each shoe upper still needs to be individually heat-set and then sewn to the insole. Where 4D seamless knitting technology may be exactly what the industry needs to solve this problem. This new technology enables flat knitting machines to produce a complete shoe upper, ready to be directly connected to the sole, with a single machine. This complete automation eliminates labour oriented cutting, sewing and heat-setting from the shoe production process and thus explores the concept of sustainability.

2.3. Reduce Production Cost

The cost depends on the number of colors and fiber types. A single colour polyester fiber design may cost $2.50, while a multi-colour, polyester spandex combination can cost $7.50 per upper with a setup fee per design of $300 against the MOQ of 1000 pairs. Sample development is fast within 7 to 10 days, this may take longer if custom colour fibers are required. Once the design is confirmed the automated production can run around the clock.

2.4. Reduce Inventory Cost

On an average, inventory costs generally represent 20-30% of the total inventory value. The main issue to reduce the inventory cost down to zero is the difficulty in accurately predict the sell performance of products and the overstocking of unpopular items. 4D knitting technology offers a solution to the inventory problem. Rather than estimate consumer demand months ahead of time and taking risks of unsold inventory, 4D knitting opens the possibility to manufacture locally according to real-time demand. Shoes even customized can be delivered within a few days, cutting down manufacturing and distribution time from several months to just a few days. Because this technology does not require any specific skill, high man power and natural materials like leather. Everything man made and automated. The Adidas Speed Factory is beginning to realize this concept on a smaller scale and planning to equip set of retail stores with a 4D knitting machine so that the customers can take their foot measurements and order customized shoes in stores.

2.5. Faster to Market Time

The fashion cycles are compressing and thus the production lead time is also reducing. But the average concept-to-market time is approximately 18 months.

Therefore this concept-to-market time need to be adjusted accordingly. With this 4D knitting technology, Adidas has managed to accelerate their concept-to-market time by a factor of 3.

3. DRAWBACKS

But there are aspects of the knitted shoe that may not work well in the outdoor arena. In soccer, having a thinner upper encasing the foot gives footballers a closer touch on the ball and thus better ball control. But with hiking and other fitness activities with considerable lateral stress on the foot, that knitted offers little stability for the ankle when traversing uneven terrain. In rock climbing, the lightweight could be an advantage, but the knitted material would need to stand up to the required stability. Nylon certainly wouldn't, so other materials would need to be developed.

In order to make a 4D knitting solution practical, a dual-sided upper must be knitted while preserving the durability and functionality of the uppers.

4. SUSTAINABILITY

4.1. Reduced Environmental Impact

Apparel companies are focusing more on sustainable product design and supply chain practices through supplier selection and monitoring of compliances with codes of conduct. Most of the hazarded emissions in shoe production are released during the material processing and manufacturing phases. An analysis between a knitted shoe upper and a traditional shoe upper is done focused on their environmental impacts as that is the main point of differentiation. Both shoes were assumed to be of men's size 9, weighs of 34 grams and comprised of recycled PET (95%), nylon (5%) and spandex (5%) for knitted, while weighs of 97.8 grams and comprised of polyurethane, polyester, nylon, and olefin copolymer for traditional. The analysis confirms that the knitted footwear reduces waste around 50%, which is very significant and generates less environmental impact across a variety of TRACI categories.

An LCA study was also done in 2013 on a pair of Asics running shoe estimated a typical carbon footprint of 14 ± 2.7 kg CO_2 equivalent, in line with their previous research done on Puma and Timberland shoes. This includes producing the entire shoe, excess scrap material, packaging and distribution.

4.2. Reduced Global Warming Potential (GWP)

Extraction and purification of raw materials and distribution create significant environmental impacts in shoe production. A reduction in GWP during any of these categories could yield substantial benefits when implemented on a global scale. Particularly noteworthy is that the knitted upper is responsible for 1.29 kg CO2 eq of GWP, which is less than half that of the traditional shoe. Maintaining current levels of consumption, a switch to knitted footwear against the traditional footwear which sold 46.25 million pairs of shoes to U.S. consumers in 2013 could result in a GWP reduction of over 67,525,000 kg CO_2 eq. annually.

4.3. Reduced Energy Use

Energy savings of 0.48 kwh are realized per pair of shoes in case of knitted footwear, resulting in savings of 79,920 GJ if all shoes sold to the U.S. market were produced using this technology.

4.4. Human Health & Non-Carcinogenic

Another large reduction in TRACI metrics created by the knitted uppers is non-carcinogenic human health impacts. It reduces non-carcinogenic emissions by almost 30% from those created by the manufacture of traditional shoes.

4.5. Minimal Solid Waste

Raw materials represent a considerable expense in the shoe manufacturing process, which is only aggravated by extreme fabric waste. For example, warp knitting machines waste around 20-25% of fabric during production (an equivalent to approximately 132.6 tons per million pairs of shoes) but using 4D knitting technology, the solid waste could be minimised as much as 60%.

4.6. Replacement of Leather

Replacement of leather with textile has a positive environmental impact. Leather shoes account for just one-quarter of total production of footwear, while the overall effect on all metrics including climate change, resource use and freshwater depletion is projected to be 30 to 80%. If compared with textile shoes, which make up just 6-21 percent of overall effect in the same categories.

5. CONCLUSION

Athletic shoes have made up around 37% of all footwear sales in 2019. Thus widespread use of this 4D knitting technique could boost the industry's efficiency, cutting down on materials, labours, lead times etc as the products can be made start-to-finish in one place. Also, the knitted footwear appears to have a lower negative impact on environment and human health than that of traditional shoes. A smaller mass is sent to landfill, less energy is used during the manufacturing phase and lower GWP is realized throughout the life of the shoe and overall leather could be replaced which is nowhere sustainable.

Therefore, the entire shoe industries need to adapt this 4D knitting technology as early as possible, so that we head out to follow the path of more sustainable and efficient future.

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No More Laundry: Self Cleaning Textiles

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ABSTRACT

Nanotechnology is the basis of self-cleaning textiles. Now a days we can have dirt, stain free clothing without paying heavy laundry bills, along with special properties like anti-bacterial, anti-odor etc. The fundamental concentration here is to consider the two critical methodologies; Lotus effect and Photo catalysis, used to bring out self-cleaning property of textiles. In this paper, various methods and assessment procedures to accomplish self-cleaning property are discussed. Nano technology provides a new concept self-cleaning textile which gives self-cleaning as well as fresh cloths every day, this is providing technical as well as techno economically benefits also. This innovation similarly can be created in other application for instance clinical materials, athletic wear, and military uniform and many more. Additionally, it is helpful as it effectively moderates water and improves the presence of nature and in long stretch it will diminish vitality, clothing cost and time also.

Keywords: Photo catalysis, Lotus effect, Nanotechnology, Self-cleaning, Superhy drophobic

1. INTRODUCTION

Self-cleaning concept has achieved significant intrigue in light because of their unique highlights and wide scope of potential applications in various fields. The phenomenon of Self-cleaning were investigated by two botanists Wilhelm Barthlott and Neinhuis, in lotus leaves. Lotus leaves cleans themselves as water drops readily roll off the surface compiling dirt particles (Neinhuis and Barthlott, 1997). This concept of self cleaning, later, was also observed on some other plants (rice leaves) and insects (wings of butterfly, fish scales, shark skin) etc (Ahmad and Kan, 2016). Later this phenomenon was utilized for various other materials that use self cleaning innovation apart from textiles, it includes inside applications, for example, textures, outfitting materials, window glasses, and solar panels, paints etc. (Feng *et al.*, 2002). Now a days, with use of nanotechnology, global commercial market of textile witness growing demand towards possessing extra functionalities to textiles such as self-cleaning, antibacterial, UV protective, environmental friendly and antipollution abilities(Palamutcu *et al.*, 2011) (Sivakumar *et al.*, 2013). Nanotechnology is playing an important role of developing self-cleaning surfaces because of the use of nanoparticles alone can disperse well on various substrates more uniformly and generate hierarchical morphology (Gulrajania and Gupta, 2011). The potential is growing and their market is truly global as they possess unique and valuable properties, more important of which is durability to laundering and wearing and reduced labor cost as well (Ganesh *et al.*, 2011).

Self-cleaning coating is a smart technology where the surface is cleaned by itself without any manpower. The self-cleaning surfaces majorly categorized into two types; hydrophobic and hydrophilic type. Both these types can clean themselves under the influence of water. In hydrophobic type, the rougher surface forces the water droplets to form beads which tends to roll off and clean the dirt part (Yan, Gao and Barthlott, 2011). The hydrophilic type works on sheeting the water on the surface and chemically breaking down the impurities by photo catalysis. Fabricated using active photo-catalyst (Banerjee, Dionysiou and Pillai, 2015).

2. SELF CLEANING BY SUPERHYDROPHOBIC MECHANISM:

Surface that can repel water droplets from wetting itself, and the contact angle of a water droplet resting on it is greater than 150^0, referred as super hydrophobic (ultra hydrophobic) surface (Marmur, 2004) (Gao and McCarthy, 2006). In nature, many natural species exhibit water contact angle higher than $150^{0.}$ Similar kind of self-cleaning mechanism, commonly called "Lotus Effect "based on surface roughness of lotus

leaves suggests that a combination of low-surface-energy materials and a specific surface topography based on a dual-size surface roughness are required to obtain a super hydrophobic surface (Koch, Bhushan and Barthlott, 2008).The outermost surface of the leaf, cuticle acts as a protective interface to the outer environment. Cuticle is a very thin layer with thickness between a few nanometers to few micrometers. This cuticle consists of a network of cutins and hydrophobic waxes. The epicuticle waxes are mainly responsible for wet ability and self cleaning properties (Koch, Bhushan and Barthlott, 2009). With rougher surfaces, the contact angle of water will increase, and form bumps that trap air between water and the surface. The surface of lotus leaf consists of microscopic bumps which play important role in lowering down the surface energy and hence make spherical water drops, with slight tilt, these spherical drops roll off and cleans the surface by taking dirt with it Fig. 1.(a,b).

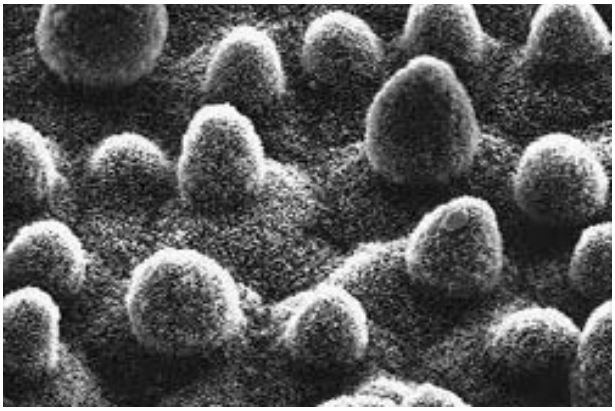

Fig 1.a) The surface of the leaf with roughness due to micro bumps

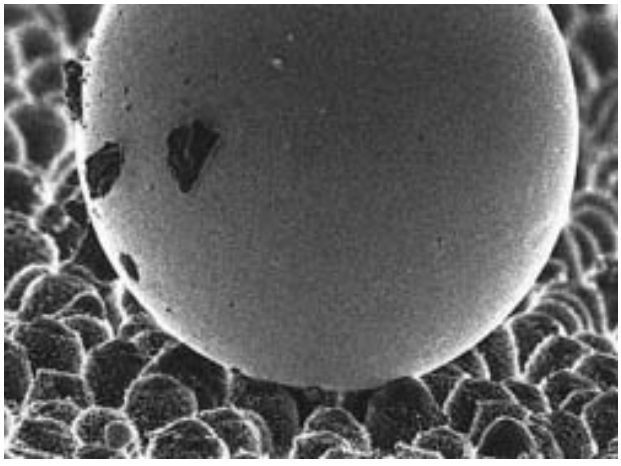

Fig 1.b) Drop of water resting on air cushions on surface of leaf

Based on the above stated mechanism of superhydrophobicity, researchers in the last few decades have tried to develop robust coatings to achieve self-cleaning to various textiles substrates. As discussed above, the super-hydrophobicity concept can be recognized by two major parameters, first is the presence of nano or micro bumps on the surface of substrate; and second is by coating it with materials of low surface energy. This can be replicated by use of artificial polymers like poly (dimethylsiloxane) PDMS by nano-casting which is a widely used nanofabrication method. (Sue, 2010). Surface roughness can also be generated in cotton textiles by functionalizing it with Silicon nanoparticles. Characterisation of the functionalities can be done by transmission electron microscopy, Fourier transforminfra-redspectroscopy and Thermal gravity analysis (Xue *et al.*, 2008). Many of the super hydrophobic coated materials are toxic and show poor mechanical durability, complicated fabrication steps etc. In order to cope up with environmental conditions, a versatile and multifunctional system is developed in recent years. It is found in recent studies that PDMS is grafted through heat and UV illumination with Mg $(OH)_2$, TiO_2 and epoxy to introduce multi-functionalities like self cleaning, anti odor, flame retardancy and high durablility to textile surfaces (Wang *et al.*, 2019).Apart from the conventional techniques of coating the fabrics, the required type of morphology of super hydrophobic surfaces can also be achieved using lithographic methods (Choi *et al.*, 2013), template-based techniques (Hou & Wang, 2009), plasma treatment, self-assembly and self-organization, chemical deposition, layer-by-layer (LBL) deposition, colloidal assembly, phase separation, and electro spinning (Sas *et al.*, 2012).

3. SELF CLEANING BY PHOTOCATALYTIC EFFECT

Photo catalytic is a kind of photoreaction by decomposing the organic contaminants into air and water by using sunlight (Banerjee, Dionysiou and Pillai, 2015).The mechanism of photo catalytic reaction begins when a photo catalyst is irradiated by light, usually ultraviolet light (UV). With the energy equal to or higher than its band gap, electrons on the photo catalyst surface are excited, and escaped from valence band to the conduction band, leading to the formation of electron-hole pairs in the surface-excited negative charged electrons (e^-) in the conduction band, and the positive charged holes (H^+) in the valence band. In the late 1960s, Akira Fujishima, researcher at Tokyo University, started

his investigation about reaction of semiconductors against light (Fujishima, Zhang and Tryk, 2008). Nanoparticles Titanium dioxide (TiO_2), Zinc oxide (ZnO) (Jašková, Hochmannová and Vytřasová, 2013), Copper oxide (CuO), Silver (Ag), Carbon nanotubes are the widely used photo catalysts which show a great functional activity towards light. (Kale, 2017). These can be applied directly using binders by dip-pad-dry process, although there are several other processes to make the coating more durable example, Sol-Gel Method where Titanium nanoparticles can be synthesized by using several precursor such as titanium tetrachloride (Dr.B.Senthil kumar, 2015), Titanium tetraisopropoxide (TTIP) (Gupta, Jassal and Agrawal, 2008).All these self-cleaning fabrics have ability to clean themselves when exposed to light. For evaluating photo catalytic activity of the fabrics, several testing methods can be used by assessing the degradation of organic contaminants. The photo degradation activity of the stains can be determined by two methods; such as solution discoloration and stain degradation(Sharma *et al.*, 2012). Concentration of dye solution can be assessed by UV-Vis Spectrophotometer, for stain degradation the coated fabric is stained with colorant (Bozzi *et al.*, 2005). After exposed to UV light for prolonged duration, the stained sample is assessed for color strength in terms of K/S values by using spectrophotometer. Percentage decrease in K/S value is then calculated by taking K/S before and after exposure for specific time duration (Ganesh *et al.*, 2011).

$$\% \text{ decrease in K/S value} = \frac{(K/S)_{unexposed} - (K/S)_{exposed}}{(K/S)_{unexposed}} \times 100$$

Where;
$(K/S)_{unexposed}$ = K/Sof Stained fabric before exposure
$(K/S)_{exposed}$ = K/S of Stained fabric after exposure
% decrease in K/S value determines the degree of self cleaning by photo degradation.

4. COMMERCIAL ASPECTS

For the products proposed by the research papers, providers of the following consumer goods were found: Stain repellent, quick drying apparel or furniture and waterproof, grime repellent outdoor clothing. Apart from these applications, the following commercial end products were found: Easy to clean luggage, water repellent umbrellas and cleaning clothes with dirt repellent properties. Furthermore, various auxiliary products for industrial production processes are commercially available. Some companies offer coating technologies for easy to clean, stain repellent textile surfaces while industrial coating agents which promise the same effect can be purchased.

5. CONCLUSION

The self-cleaning finishes applied on textile surfaces by using the nanotechnology have a vast potential for the development of new materials or new products. This will lead to a new growth stage. For the growing market of technical textiles a further increase in production volume, sales and application fields can be expected by successful transfer of the self cleaning effect on textile materials. Because of characteristics like low maintenance, lesser time and energy consumption, cost efficient, durability, these self cleaning textiles are of great economic significance.

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Grewia Optiva (Bhimal) Fibres: Evolution from a Branch to a Textile Yarn

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ABSTRACT

Grewiaoptiva, bhimal trees, from which bhimal fibres are extracted from their branches, are generally found in the north western and central Himalayan regions covering Uttarakhand and Kandi belt of Jammu and Kashmir. They are grown extensively as they are multi-purpose trees catering to the needs of fuel, fodder, timber, food and fibre at the same time. They form boundaries of agricultural fields of farmers as they grow them for the above mentioned uses. Local inhabitants have used traditional method of retting in water bodies in summer months as a method for extraction of bhimal fibres by dipping branches for 45-50 days and then beating it to separate the fibre from the branches. Women are mostly involved in this activity and it provides income generation to them by selling various types of handicraft products and ropes. But this process is time consuming and is dependent on various factors such as temperature, flow of water in the water body, bacterial growth etc. Therefore, chemical extraction of bhimal fibres was attempted in this study to upscale the production of bhimal fibres for commercialization of the craft. Bleaching was carried out on extracted fibres and a commercial polysiloxane softener was applied to complete the process of extraction. These fibres were spun into yarn by blending with a natural and a man-made fibre and different yarn properties; yarn count, yarn strength and elongation and yarn twist were compared.

Keywords: bhimal, natural fibre, extraction, blended yarn

1. INTRODUCTION

The projected increase in the consumption of natural fibres according to the rate of growth of population is alarming. The requirement of natural fibres is expected to touch 35-40 million tonnes per year by the middle of this century. This demand should be met by the rise of in cotton production, which should reach up to 26-30 million tonnes per year and the rest may be compensated man-made cellulosics and/or other natural resources including bast fibres (Srivastav Ed., 2009). Recently, the interest for renewable resources of fibres of plant origin is increasing and several non-traditional plants are being explored with the aim of isolating fibres. *Grewiaoptiva*, bhimal is one such promising tree with multiple uses, being grown and used since years by the local inhabitants of Himalayan regions. Bhimalis the centre of agro-forest-livestock management system in the Himalayan regions, useful in a number of ways. It is abundantly grown along the boundaries of agricultural fields basically to feed the livestock but has a lot of other benefits too-the fruit is edible, the leaves are used for feeding livestock, used as source of fuel, wood is used for making general purpose furniture, the branches are used as torches, and also used for extraction of natural fiber from them (Uttarakhand Bamboo and Fibre Development Board, 2011).

2. SIGNIFICANCE

There have been attempts by various organizations like BAIF Development Research Foundation and Himalayan Environmental Studies and Conservation Organization (HESCO) to extract fibres from *Grewiaoptiva*. But the process has not been standardized yet. It is one of the perennial multi-purpose plants that can be grown on degraded lands which are unsuitable for agricultural crops and provide good economic utilization of such lands (Singh, 2010). The possibility of extracting fiber from its branch therefore, can produce fiber with good inherent desirable textile properties. This will also help reduce the burden on conventional textile fibres.

3. MATERIALS AND METHODS

3.1 Extraction of textile fibres from Grewiaoptiva (bhimal)

- **Collection and preparation of *Grewiaoptiva* branch**- Collection of raw material in the form of branch from which fibre was extracted was done with the help of non-governmental organizations based in Uttarakhand.

- **Optimization of recipe of extraction-** As per the review of literature conducted, different chemicals which were being used for extraction of bast fibres like jute, bamboo, banana, flax, hemp, kenaf, ramie, etc. were tried for extracting bhimal fibre. Testing trials with, water, different alkalis, different acids, sodium benzoate, HTHP treatment and urea were carried out.

- **Optimizations of extraction procedure with urea-** Different concentrations of urea were used after pilot testing to find the range in which effective separation of fibres was seen. Then different concentrations within this range were used for retting.

- **Bleaching cum further individualization using hydrogen peroxide-** Bleaching was carried out using hydrogen peroxide at different concentrations and time and optimised on the basis of whiteness index obtained.

- **Application of softener to extracted fibres-** An amino modified poly siloxane softener was used manufactured by Resil Chemicals Pvt. Ltd. It imparts smooth handle and added lustre to fibres. It is, cationic in nature and compatible with cationic and non-ionic textiles. It is colourless to pale yellow pourable pasty liquid.

- **Manual combing of softened fibres**

  Bhimal fibres extracted were in ribbon form, joined to each other side by side and required individualization before proceeding further for yarn development.

3.2 Yarn development with natural /man-made fibres and testing of yarn properties

In this phase of work, prototypes of yarn were developed from the extracted bhimal fibres and their properties were tested. Blended yarns of bhimal were developed with cotton and viscose fibres in different ratios. These were then tested and compared for different yarn properties; yarn count, yarn strength and elongation and yarn twist. After manual combing and separation of the fibres, yarns development and testing of properties of yarns were carried out at NITRA (Northern India Textile Research Organization) on its Pilot Plant. Two blend ratios of cotton and viscose with bhimal were carried out-50:50 combination and 70:30 combination of bhimal-cotton (BhiCo), and50:50 combination and 70:30 combination of bhimal-viscose (BhiVi). Ring spun yarn was constructed from these combinations.

3.3 Testing of Yarn Properties

The yarns developed from BhiCo blend-70:30 and 50:50 and BhiVi -50:50 were compared for their yarn properties-yarn count, yarn strength and elongation and yarn twist using standard test methods. Yarn count was reported in English count (Ne). The amount of twist in developed yarn samples was determined as per IS:832 Textiles- Determination of Twist in Yarns Part II Untwist/retwist method for single spun yarns 2011, using the Microprocessor twist tester. Yarn Strength and Elongation was tested on Uster Tensorapid 4 as per IS 1670-1991 Textiles-Yarn- Determination of Breaking Load and Elongation at Break of a Single Strand.

4. RESULTS AND DISCUSSION

4.1 Extraction of textile fibres from Grewiaoptiva (bhimal)

- **Collection and preparation of Grewia optiva Bark**- The procured raw material was cut from a five year old tree in the month of December near village Ambiwala, District Dehradun. The branches were further cut into 11-15 inch pieces for convenient use during retting and chemical treatments. They were further reduced to 4-5 inches pieces to allow proper dipping in beakers during chemical treatments.

- **Optimizations of Recipe of Extraction-** Aseries of experiments were conducted in order to optimize a procedure for extraction of good quality fibres with desirable textile properties.First of all, different alkalis were used as most plant fibres can be extracted using alkali boiling starting from mild alkali moving towards the stronger alkalis. But in case of bhimal fibres, satisfactory separation of fibrous layer and individualisation of fibres was not obtained. So, other chemicals like different acids, sodium benzoate and urea were tried. Finally, urea

retted fibres were found to be best individualised and further treated with hydrogen peroxide to bleach cum individualise the fibres further.

- **Optimization of extraction procedure with urea-** Different concentrations of urea were experimented and it was finalized on the basis of yield and bundle strength which varied of the extracted fibres.

- **Bleaching cum further individualization using hydrogen peroxide**-bleaching with hydrogen peroxide lead to further individualization of bhimal fibres and also improved fiber appearance in terms of improved texture and handle.

- **Application of softener to extracted fibres**- The softener used was silicone based compatible with both cationic and non-ionic textile materials. The result was smoother appearance and softer feel of the fibres with an added lustre.

- **Manual combing of softened fibres-** They were combed manually with the help of a plastic foil cutter. Small sections of bhimal ribbons were combed at a time and then trimmed to a size of 40mm. as per the requirement for spinning on cotton spinning machinery

4.2 Yarn development with natural /man-made fibres and testing of yarn properties

Yarns of the mentioned combinations were ring spun. Blowroom operations of opening and cleaning of bhimal fibres was done manually. To form a lap from opened bhimal fibres, they were passed through a carding machine called Mini-Card. In carding, the fibres passed through revolving rollers with very fine hooks or wire brushes. The cylinder pulled the fibres in one direction, disentangled them and arranged them parallel in the form of a thin film or web. Bhimal fibres were dyed to make identification of bhimal in blend easier and cotton taken was raw unbleached cotton which is off-white in colour and viscose was white. Carded laps were passed through breaker drawing machine- Lakshmi Rieter DO/2S Draw Frame and slivers were formed Each lap got divided into four parts. Eight such parts were combined before passing the assembly through finisher drawing and sliver was further drawn to make sliver more parallel on the same equipment. During finisher drawing, the sliver passes through a series rollers rotating at different rates of speed which elongated and drew out the sliver into single more uniform strandThe drawn sliver was then passed through Speed Frame-Lakshmi Rieter- GS which further elongated the sliver and a slight twist was also inserted. The strand of fibres was converted into a roving and was wound on spools. Roving was fed from the spools through the rollers of Ring frame-Lakshmi Rieter-DJ/5. The rollers elongated the roving which passed through the eyelets and through the traveller. The traveller moves around the stationery ring at a constant speed which inserted a twist in the yarn and it was wound onto a bobbin. BhiCo yarns were successfully developed in two combinations of 70:30 (Figure 1a) and 50:50 (Figure 1b) bhimal to cotton, but BhiVi yarn could only be developed in 50:50(Figure 1c) combination, since a lot of bhimal fibres fell off during carding in 70: 30 BhiVi combination.

a) b) c)

Fig. 1. Blended yarns of bhimal a) 70:30BhiCo b) 50:50 BhiCo c) 50:50BhiVi

4.3 Testing of Yarn Properties

Ring spun yarns of both combinations Bhi Coand 70:30 Bhi Viwere compared for their yarn properties.Highest yarn count was recorded of 50:50 BhiViyarn which indicates that it was the finest yarn amongst all three yarns developed. Lowest yarn number was found in 70:30 BhiCo, indicating that it was the coarsest (Table 1). Tenacity and elongation of BhiCo yarns-70:30 and 50:50 were lower as compared to 50:50 BhiVi yarn (Table 1). This may be since BhiCo yarns had a higher number of thick and thin areas which led to loss of yarn strength (Sakthivel et al., 2005). As shown in the Table 1, yarn twist of both yarns of BhiCo blends was higher

and almost similar irrespective of the difference in blend ratio. Because of higher twist as compared to BhiVi yarn, these yarns also appeared more hairy. All three yarns developed had Z twist.

TABLE 1: Physical properties of blended bhimal yarns

S. No.	Yarn type	Count (Ne)	Tenacity (g/tex)	Elongation (%)	Yarn twist
1.	70:30 BhiCo Ring spun	2.98	2.90	4.42	14.50
2.	50:50 BhiCo Ring spun	3.4	3.82	6.19	14.07
3.	50:50 BhiVi Ring spun	7.64	6.22	7.31	8.94

5. CONCLUSIONS

Bhimal blended yarns with cotton and viscose have shown considerable physical properties; better in case of BhiVi combination as compared to BhiCo combination. By traditional process of retting it is not possible to extract such fine fibres as done by urea retting, bleaching, softening and manual combing combination. Chemical extraction of bhimal fibres using urea is an eco-friendly process since it saves the pollution of water bodies as in the case of traditional retting method and urea is a mild chemical which is practically non-toxic.

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Bioactive Antimicrobial Agent for Finishing of Cotton for Healthcare Products

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ABSTRACT

The inherent ability of the antimicrobial textiles to impede the growth of disease causing micro-organisms has created awareness related to combating the hospital related diseases. This will lead to better healthcare practices and thus, boost demand for antimicrobial textiles. The increasing penetration of antimicrobial textiles in the global textile market is attributed to the rising number of durable and safe antimicrobial finishes. Although, numerous antimicrobial textile materials have been developed using a variety of synthetic active agents such as triclosan, metal and their salts, phenols, quaternary ammonium compounds, and organometallics, most of them are toxic and can cause adverse effects on human health and environment. This paper highlights the possibility of using Ratanjot, a natural dye as a bioactive substance on cotton for imparting antimicrobial property for developing healthcare products.

1. INTRODUCTION

Healthcare and hygiene sectors forms an important part of the medical textile industry. Textiles find immense application in the healthcare industry and therefore, the need to finish the textile materials, which will eventually protect it from various microbes such as bacteria, mould or fungi, is increasing. The large surface areas and the ability to retain moisture make textiles more prone to bacterial growth, and thus they provide an ideal environment for microbial growth, providing oxygen, water and warmth, as well as nutrients from spillages and body exudates (Singh et al., 2005, Giridev et al., 2009). As the textile materials act as carriers of the bacteria, thus they pose high risk of infection in healthcare facilities. As a result, the usage of antimicrobial fabric in medial textiles is greatly encouraged and has a promising growth during the future period.

Although, synthetic organic compounds such as quarternary ammonium compounds, triclosan, polyhexamethylene biguanides are effective against a broad spectrum of microbes, bacterium and fungi, but they are mostly toxic and cause adverse-effects on human health and environment (Babu and Ravindra, 2015).

Natural dyes extracted from various sources such as plant, animal or mineral origin have been reported to possess medicinal properties (Singh et al., 2005, Giridev et al., 2009). One such natural plant is Ratanjot, botanically called as *Arnebia nobilis* Rech.f., whose naphthoquinones are known for its medicinal properties.

Natural fabric, cotton is being used in innumerable applications including medical textiles, apparel, commercial textiles, automotive, home textiles and other such applications. Cotton poses a disadvantage of being susceptible to microbial attack (Global Antimicrobial Textile Markets, Forecast to 2024, 2019). Therefore, aim of the study is to investigate the antimicrobial properties of naphthoquinones extracted from Ratanjot on cotton fabric for developing healthcare products.

2. METHODOLOGY

2.1 Materials

Scoured plain woven cotton fabric was used for all the experiments. Laboratory grade chemicals were used for the study. Cationising agent (Optifix F and Optifix 2000) were procured from Clariant Ltd., New Delhi. Ratanjot (*Arnebia nobilis Rech.f*) dye was procured in the form of dried barks from local markets of Delhi.

2.2 Extraction of dye

Ratanjot barks were cleaned up manually so that impurities could be removed. The bark was ground manually to get a coarse powder.

(a) In aqueous medium

Dye was extracted from Ratanjot bark in aqueous medium (100 ml) at varying pH viz. 5 (maintained using acetic acid) and 9 (maintained using sodium hydroxide) at boil for a period of 60 minutes. The extracted dye was sieved through nylon mesh in order to remove any suspended particles. The extracted liquor was used for dyeing.

(b) In n-hexane

Extraction of dye was carried out in n-hexane at 50°C for 90 mins. M.L.R was taken as 1:20. Extracted dye was sieved through muslin cloth and the solvent was evaporated to obtain the dye in powder form.

2.3 Pre-mordanting of the cotton fabric

Cotton sample was pre-mordanted with alum (10% owf) and ferrous sulphate (6% owf) at 80°C for 30 minutes. M.L.R was taken as 1:40. The fabric was then squeezed and dried.

2.4 Cationization of cotton fabric

The scoured fabric was treated with 16% owf cationizing agent (Optifix 2000 and Optifix F) at 40^0C for 30 minutes. M.L.R was employed as 1:30.

2.5 Dyeing of cotton fabric

The pre-mordanted cotton fabric was dyed with 6% and 12% owf dye extracted using n-hexane. Fabric was also dyed with $1/4^{th}$ and ½ MLR of aqueous dye extract, both acidic and alkaline. The dyeing was carried out at boil for 60 minutes at pH 7. M.L.R was maintained at 1:30. After dyeing, samples were rinsed and soaped followed by drying.

Cationized cotton was also dyed using the same procedure except the pH was maintained at 5.

2.6 Colour measurement

Data colour spectrophotometer was used to analyse the K/S, $L^*a^*b^*$ and $L^*c^*h^*$ values of the dyed samples.

2.7 Antimicrobial activity

The dyed cotton fabric was assessed for its antimicrobial activity against Gram negative bacteria (Escherichia coli) using qualitative parallel streak method (AATCC147).

3. RESULTS AND DISCUSSION

Purple colour dye solution was obtained using n-hexane. Aqueous extraction at pH 10 gave dark blue solution whereas dye solution extracted at pH 4 was light brown in colour.

3.1 Dyeing of premordanted and cationised cotton

The alum mordanted fabric when dyed with n-hexane showed red-blue colour whereas, the alkaline and acidic aqueous dye solution showed red-yellowish colour. The fabrics pre-mordanted with ferrous sulphate showed shades of brown. The ferrous sulphate mordanted samples showed darker shades as compared to alum mordanted samples.

Cationised cotton on dyeing with n-hexane and aqueous dye extract obtained red-yellowish shades.

The decreasing order in which K/S was obtained using various mordants and cationising agents is as below:

Ferrous Sulphate > Alum > Optifix 2000 > Optifix F

3.2 Assessment of antimicrobial activity

The cotton fabric premordanted and dyed with dye extracted from *Ratanjot* bark in n-hexane and aqueous medium at acidic and alkaline pH were qualitatively assessed for their antimicrobial activity against gram negative bacteria, *E.coli.* The dyed samples were assessed by parallel streak method.

The qualitative assessment of the antimicrobial activity of the control and unmordanted-dyed cotton samples showed significant bacterial growth on the fabric surface. The alum mordanted samples dyed with dye extracted in aqueous medium at alkaline pH and in organic medium showed almost complete lack of bacterial growth underneath the samples. The dyed fabrics didn't show any zone of inhibition.

However, the cotton fabric dyed with dye extracted in aqueous medium at acidic pH did not show any activity. Similar results were observed when the samples were

first treated with cationising agent and then dyed. Almost negligible growth of bacteria was observed on the cotton fabric premordanted with ferrous sulphate and then dyed with the dye extracted in aqueous medium at acidic and alkaline pH.

4. CONCLUSIONS

Shades of brown and red-blue were achieved on cotton fabric using dye extracted from Ratanjot bark. Various mordants and cationising agents improved dye uptake on the fabric. Moreover, antimicrobial properties have been obtained in the dyed samples, which can be successfully used in the health and hygiene industry and medical textile applications.

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A Study on Evolution of Khadi and Current Factors Leading to Potential Opportunities in Khadi Sector

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ABSTRACT

Khadi Fabric is very indigenous to India. There are many traces in Indian history which shows evidences of fabric which was hand spun and hand-woven using natural fibres. Before India got its independence from Britishers. Ghandiji through Swadeshi movement revived Khadi as a tool to attain freedom by boycotting foreign made goods and promoting the ideology of being self-reliant and self-sustainable India. After Independence the popularity of Khadi declined though even after government's initiatives to promote this sector. It was in 1990's that for the first time designers started adopting Khadi and since then today Khadi is revamped and used and promoted by many designers. The paper aims to study evolution of Khadi over the period of time and discusses various key factors which are leading to growth in this sector.

Keywords: Khadi, Growth Factors

1. INTRODUCTION

Khadi also Known as Khaddar is one of the important segments of textile sector in India. Khadi is a hand-woven natural fibre cloth originating from eastern regions of the Indian subcontinent, mainly Eastern India, North-eastern India and Bangladesh, but is now broadly used throughout India and Pakistan. Khadi fabric is a cloth made from hand spun and hand-woven yarn from cotton, silk and wool fiber or from a mixture of any two or all of them. The fabric is known for its rugged texture, comfortable feel and its ability to keep people warm in winter while keeping them cool during summers. It has a handcrafted self-texture making each Khadi cloth unique. Khadi in India is being promoted by the Khadi and Village Industries Commission and the Ministry of Micro, Small and Medium Enterprises.

The purpose this study is to understand the evolution of Khadi over the period of time and discusses various key factors which are leading to growth in this sector. This conceptual paper is solely based on the review of literature. Relevant literature from selected thesis, books, reports, research and news articles published in leading journals and other renowned platforms were subjected to analysis and synthesis to form a conceptual framework.

2. EVOLUTION OF KHADI

Ancient History of Khadi Fabric - The origin of Khadi fabric can be dated back to ancient civilization of Mohenjo-Daro by historians where they mention about presence of hand-woven cloths that are so similar to the texture of Khadi. Khadi had a special recognition and popularity in the Mauryan Era. It is also mentioned in Chanakya's "Arthashastra" where at that time many expert artisans were producing cotton cloth material that played pivotal role in that era's economy. The imagery of Khadi can also be traced in Ajanta Caves. Other than this there are many mentions of Khadi and similar kind of fabric at many places in ancient Indian history and it is a symbol of Indian rich textile heritage which has evolved over the decades.

Khadi for Independence - In 1918, Mahatma Gandhi started the Khadi movement as a relief program, for the poor masses living in Indian villages (What is Khadi, n.d.). The Khadi movement aimed at boycotting foreign goods and promoting Indian goods. Hand Spinning and handloom weaving were elevated to an ideology for self-reliance and self-government. Gandhiji saw it as the end of dependency on foreign machine made materials and thus giving a first lesson of real independence. Khadi became a tool for betterment of people of India especially in rural areas. Khadi is very closely associated

with India's freedom movement and it's a matter of pride for every Indian. Khadi then was a very minimal fabric in plain white and coarse in texture (Historical Development of Khadi, n.d.).

Declining Khadi Post Independence -In the decades after Independence, the government institutionalized the Khadi sector by setting up the Khadi and Village Industries Commission (KVIC) in 1957, through an Act of Parliament, with the aim of providing employment to poor and rural community in India by production of saleable articles. The commission works towards supplying raw material and implements to producers, promoting research in production techniques, quality control of Khadi products and promoting the sale and marketing of these products. However, in popular culture during the post-independence period, the perception of Khadi changed. Khadi became synonymous with politicians and subsequently corruption (Historical Development of Khadi, n.d.). Khadi was not much in choice of fashion designers till 90's. In 1989 the first high end Khadi fashion show by designer Devika Bhojwaniwas presented in Mumbai by the Khadi and Village Industries Commission (KVIC). In 1990, designer Ritu Kumar of Delhi presented her first Khadi collection at the Crafts Museum (Historical Development of Khadi, n.d.). Moreover, in order to add features like durability, crease retention etc., in its hand-spun and hand-woven cloth range, production of Polyvastra was initiated. Polyvastra carries almost all the characteristics of Khadi, the only difference being that Polyvastra contains man-made fiber, which is blended with natural fibers used in Khadi. Both, Khadi and Polyvastra have been considered as a low cost and effective tool for providing reasonable earnings to the rural artisans, particularly women.

Designer Khadi at Present- Post 90s, Khadi had started becoming a fashion statement and as India stepped into the 21stcentury, a new breed of Indian designers began experimenting with this versatile fabric, ensuring that Khadi remained in vogue. Several leading designers have taken on the fashion challenge to reinvent the humble fabric into high-fashion wear. While new-age Khadi products in India are not what you would really call for masses as they are really expensive and less in market supply. Now, designers are coming up with clothes that are made from Khadi and are recognized by celebrities, artists, tinsel town faces and politicians too. In recent time the government is also actively boosting Khadi sector to make Khadi an 'Indian brand' and promoting it globally and thereby giving rise to economy of our country. Also one of the reasons for increasing demand of Khadi fabric is change in consumer behavior. Today's consumers are becoming more conscious in their fashion buying choices where choosing a sustainable fashion product is becoming a priority for consumers. The low carbon footprint of Khadi makes it as one of the most sustainable Fabric option in Fashion market. Blending Khadi fabric with trendy designs in a sustainable way is what today's consumer are looking for. With time, a retiring fabric which was once known as poor man's cloth is now becoming popular among the elite and rich class.

3. CURRENT FACTORS LEADING TO POTENTIAL OPPORTUNITIES IN THIS SECTOR

Growing Fashion and Retail Industry - The fashion industry is a global business of 1.3 trillion dollars, which employs more than 300 million people worldwide (BOF & McKinsey, 2019) and represents a significant economic force and a substantial driver of global GDP (BCG, 2019). **India is increasingly becoming a focal point** for the fashion industry, reflecting a rapidly growing middle class and an increasingly powerful manufacturing sector. According to Mckinsey Fashion Scope data India's apparel market will be worth $59.3 billion in 2022, making it the sixth largest in the world. (A. Imran, B. Anita, B. Marco, B. Achim, H. Saskia, and R. Felix ; 2019).In such dynamic scenario the still largely unorganized Indian retail has tremendous potential for growth in existing and new emerging market. Indian Fashion Businesses are innovating and growing specially by leveraging technology which is giving them an opportunity not just domestically but also globally. Also with a steady increase in the overall retail spending of the Indian consumer, and specifically that of the fashion segment, India has seen a rapid increase in brands, both local and international, in recent years.

The Fashion retail broadly comprises of several segments or categories such as Women's wear, Men's wear, Kid's wear, Luxury items, Accessories' mainly footwear's, bags and jewelry. The fashion retailers are trying to drive profitability by effectively handling these categories and treating each category as an independent business unit. The Fashion Retail business tries to understand the opportunities, emerging trends, risks, challenges and key drivers that influence each category growth. Innovation and product diversification opportunities in each category becomes important for

fashion businesses to create a competitive edge and sustain in such highly competitive market.

Sustainability becoming a Pivotal Issue in Fashion Industry–The Fashion industry is one of the largest pollution generating industry in the world. By 2030, it is predicted that the industry's water consumption will grow by 50 percent to 118 billion cubic meters (or 31.17 trillion gallons), its carbon footprint will increase to 2,791 million tons and the amount of waste it creates will hit 148 million tons (Sumner, M.2019). Due to the growing concern about the harmful impact that the Fashion industry has on earth Sustainability issue in fashion industry is surfacing across the globe. It is becoming imperative for Fashion business to not just care about their profits but to equally care for environmental and societal impact. Sustainable fashion is a recent movement within the fashion industry that aims to reduce textile waste and environmental depletion while increasing ethical treatment of workers; the goalis to slow down the global production and consumption process in order to form an industry that will be more sustainable in the long run (Z. Kutsenkova 2017). The idea that clothing could be made in a way that would maintain "ecological, social, and cultural diversity" and encourage "innovative business models" grounded what would become a sizeable movement and departure away from the phenomenon of "fast fashion" (Ozdamar, 2015). Sustainability as a movement has gained traction in the business world as a entrepreneurs and CEO's work to create solutions that allow for the formulation of ecologically friendly products that consumers actually desire over their non-sustainable counterparts (Z. Kutsenkova 2017).

The growing interest in sustainable fashion has been stimulating fashion houses and retailers to take action. Designers such as Stella McCartney and Edun have focused on producing vegan products and establishing fair trade-based relationships (Dach et al, 2014). In 2004, the first Ethical Fashion Show was held in Paris (Hannes et al, 2016). Even established powerhouses, like Louis Vuitton Moët Hennessy Group, got involved by acquiring a 49% stake in Edun. Further, the trend towards sustainable fashion has also reached large scale fashion brands, such as H&M with its organic Conscious Collection and MUJI's fair trade products (Lion et al, 2016).

In Indian Fashion Industry also sustainability is becoming a major pillar for growth and development. Indian top Fashion brands and even Fashion startups are taking sustainable initiatives for business growth. Textile companies like Pratibha Syntex, Arvind Mills, Madura Fashion and Lifestyle are the examples of businesses that have started taking Sustainability as a one of the core business strategy for their growth. New age Fashion and Lifestyle brands like Anita Dongres– GrassRoots, Nicobar, Good Earth, Anokhi, No Nasties, Doodlage, Ka-Sha and Upasana are few brands to name whose business core lies on Sustainability.

There have been several efforts and initiatives globally as well as in India to make sustainability issue imperative for the Fashion industry. In India Involvement and pressure from government bodies towards sustainability is a motivating factor for Fashion business to adopt Sustainable practices. Also the availability of indigenous sustainable textile material and various sustainable textile techniques and processes in India gives fashion business a tremendous potential opportunity to experiment, develop and growth Sustainable Fashion Businesses. As very soon Indian apparel market will be becoming 6thlargest in the world and though at the moment the market share for sustainable business is very less in India but it has huge potential to growth rapidly in coming future.

Change in Consumer Behavior – Fashion reflects our society, culture and the people living in it. Understanding consumer behavior in Fashion industry involves the study of various processes involved to satisfy the Fashion related needs of customers. In today's time Fashion and Retail industry is undergoing many changes because of various driving factors and this is also impacting consumer behavior. The buying decision making process of today's consumer for a Fashion product is driven by many influencing factors. Understanding these influencing factors become very important for business to offer the right solution to a Fashion consumers need. Hence it can be said that today's consumer is changing the pace of Fashion business. Today's consumers are more aware and educated and with the help of technology especially digital technology have empowered them. The changing fashion needs, the changing fashion buying practices and preferences and the changing Fashion consumption pattern is bringing a huge shift in consumer behavior patterns. And in order to understand these patterns business is taking help of Data driven solutions to formulate business strategies.

The Indian consumers and their apparel preferences are also constantly changing. Below are the few points which highlight the change and shift in Consumer Behavior pattern among Indian Consumers (G. Sashwat 2018).

- The apparel preferences which were deeply rooted to immensity and richness of Indian culture is now aligning itself to more refined and globally on-trend fashion. Contemporary Indian apparel has more variations and segments today, than ever before. This shift is due to the plenteous exposure of Indian consumers.
- India has largest Gen Y or millennial consumer population across the globe who are aspirational and spend much more and which reflects in their Fashion product consumption behavior also.
- Also there is a shift in the growing Indian middle class consumer who are value conscious and at the same time looks for a fashionable product. They seek quality and design at the best price.
- The semi-urban and small town consumers spend more on apparel and there is increasing adoption of ready to wear rather than home stitched apparel and increasing acceptance of western casuals.
- Also on urban side women entering in workforce is constantly increasing. Hence, the need of dressing smart and willingness to look better is driving urban women to increasingly accept western wear, leading to women western wear market showing more traction and wider acceptance in urban areas. Therefore, women western wear markets are big opportunities for growth and investment.
- The urban consumer's way of living has dramatically changed. With this, the occasions and reasons prompting apparel consumption have also increased. Today, urban consumers are buying apparel which serves a specific occasion/ usage e.g. they prefer plain shirts for meetings, checked or striped shirts for casual interactions, and shirts with funky patterns for night parties.

Also globally there is a shift happening in consumers where they are trying to adopt sustainable product options. Various recent studies have found that millennials or Gen Y are willing to pay extra for sustainable offerings. Generation Z is willing to pay more for products and services that come from companies who are committed to positive social and environmental impact. Global citizens especially citizens in developed countries know they cannot keep consuming like we do now. The choices that the consumers are now left with are either to buy we ecological products to reduce the ecological footprint, or to reuse what they have now. This is the primary why consumers are making conscious clothing decisions and gradually heading towards sustainable fashion (A. Nupur, 2018).

Khadi Market – Khadi Sector in Fashion industry has grown rapidly in recent time. KVIC through its marketing initiatives is rigorously working to make Khadi a global brand. Holding various exhibitions in India and Globally Khadi is trying to maximize its reach within its consumers. Also, to promote Khadi amongst youth community KVIC is approaching schools, colleges and industries to explain the importance of Khadi. Another effort by KVIC's to promote Khadi is their collaborative efforts with big companies like Raymond, Aditya Birla Fashion and Retail, Arvind mill etc. to popularize this fabric. Over the period of time not just domestically but Khadi export has also been increased due to surge in demand for handmade and sustainable fabric options in global market. The recent growth of Khadi sector speaks volumes about importance of Khadi in contributing towards Indian economy.

The below growth figures from KVIC provides the indication of tremendous growth potential in this sector in future.

YEAR	SALE (□ Cr)	GROWTH (%)
2013 - 14	1,217	6
2014 - 15	1,311	8
2015 - 16	1,664	27
2016 - 17	2,147	29
2017 - 18	2,510	17
2018 - 19	3,215	28
2019-2020	4211	31

Fig. 1. Growth of Khadi Sector
(Source: KVIC Annual Report 2018-19)

In India Khadi sector is totally regulated by the government i.e., its entire production process, sales, distribution and marketing is mainly controlled by KVIC. Brands can use Khadi name on their product by getting a 'Khadi' mark Regulation Certificate from KVIC. This helps to control and ensure the authenticity of Khadi product in the market. These Brands using

khadi are introducing new designs in the market to appeal to the new breed of Fashion-conscious generation. Khadi is an emerging choice of fabric among brands in Indian market but yet to tap many product category and design opportunities. At Present Khadi apparel market in India offers men's wear with limited design in casual and formal wear category. Khadi apparels for women's is mostly available in Indian ethnic wear, Indo western wear category and very limited in western wear. Khadi has found a special place and new designs with few contemporary brands like – 11.11/ eleven eleven, Akaaro by Gaurav Jai Gupta, Red Sister Blue, Bunosilo, Runaway Bicycle, Brass Tacks, Metaphor Racha, Maati Crafts, Anita Dongre Grassroot, I Wear Khadi, The Khadi Staple These brands along with KVIC are working towards improvement of quality, improvement of designs as per latest fashion trends and product diversification using Khadi materials.

Improvement in area of quality and design and product diversification can lead to tremendous potential opportunities for Khadi in domestic as well as global market. Indian millennial who are growing more towards adopting stainable lifestyle look at khadi as an icon of sustainability. Moreover, the original ideology of Khadi which started with 'swadeshi' moment to become self-reliant and self- sustainable can also be effectively reinstated and backed with other government initiatives like "Make in India" and "Skill India" for fashion Industry. Hence a lot can be done in Khadi market by keeping the original essence of Khadi and still making it fit for the modern society.

4. CONCLUSION

Recently Khadi is becoming more popular and the boost due to several factors to this retiring textile segment has expanded the scope in Khadi sector. The Fashion Industry in India is continuously growing and probably Khadi sector has opened new potential opportunities. It can become a very effective tool for providing reasonable earnings to the rural artisans and particularly women. Also it has a potential to satisfy the need of modern consumers who are looking to buy consciously and mindfully which leads to a sustainable future. Various government initiatives is giving boost to this sector and as Sustainability is becoming main stream in Fashion industry and Khadi sector becomes more important to achieve these Sustainability goals of business. Khadi Sector is yet to utilize its full potential by tapping new opportunities by improving quality, design and product diversification opportunities.

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Evaluating Sustainable Practices and Economic Viability of a Small-Scale Indian Fashion Business Model
A Case Study on Siahi

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ABSTRACT

The value of fashion business, globally was estimated to be $1.78 trillion (Objective, 14 May 2018), but is also the 2nd largest polluter of the world. In the last 3 decades Fashion business models have gained economic growth by focusing on cheap labor and profit making through increasing volume, speed & margins. The skilled craftsmen, artisans & farmers are falling under the tag of labor than a resource. Consumers are ill-informed & disconnected with the supply chain. Leading to irrational, irresponsible marketing & promotions led behavior by them, brands & manufacturers.

Over-consumption of natural resources, mass social unrests, lack of transparency in supply chain, are issues that if not answered may lead to making fashion products undesirable. This has happened, mainly due to lack of quantifiable accountability at social & environmental level but also due to lack of profitable sustainable business models for existing & upcoming businesses. This creates a need to do detailed study & research towards developing tools & business plans that are not focused only on profit, but also on people & planet, providing sustainable development opportunities. (Gjerdrum Pedersen, (2014)).

In context to the above problems & needs, this Case study focuses on studying business practices & targets of an Indian sustainable fashion start-up, SIAHI, producing environmentally sustainable product line under brand names AMPERSAND & SAND (Mehra, n.d.). The case study evaluates Siahi's sustainable business running practices & growth barriers.

The research has been conducted through detailed questionnaires, interviews directly from Ms. Priyansha Mehra, Proprietor of Siahi. The study has focused on deeply understanding all the business practices & business model constituents of AMPERSAND & SAND covering sourcing, supply chain, retail model, marketing & promotions communications along with all the existing partnerships & collaborations. Conclusions & recommendations are aligned with the brand's short, medium- and long-term targets. The study analysis, Siahi's resource impact and future product diversification options, as it's response to critical economic slowdown especially after year 2020's Covid 19 pandemic situation.

Keywords: Sustainability strategy, business model constituents, circular business model, economic sustainability

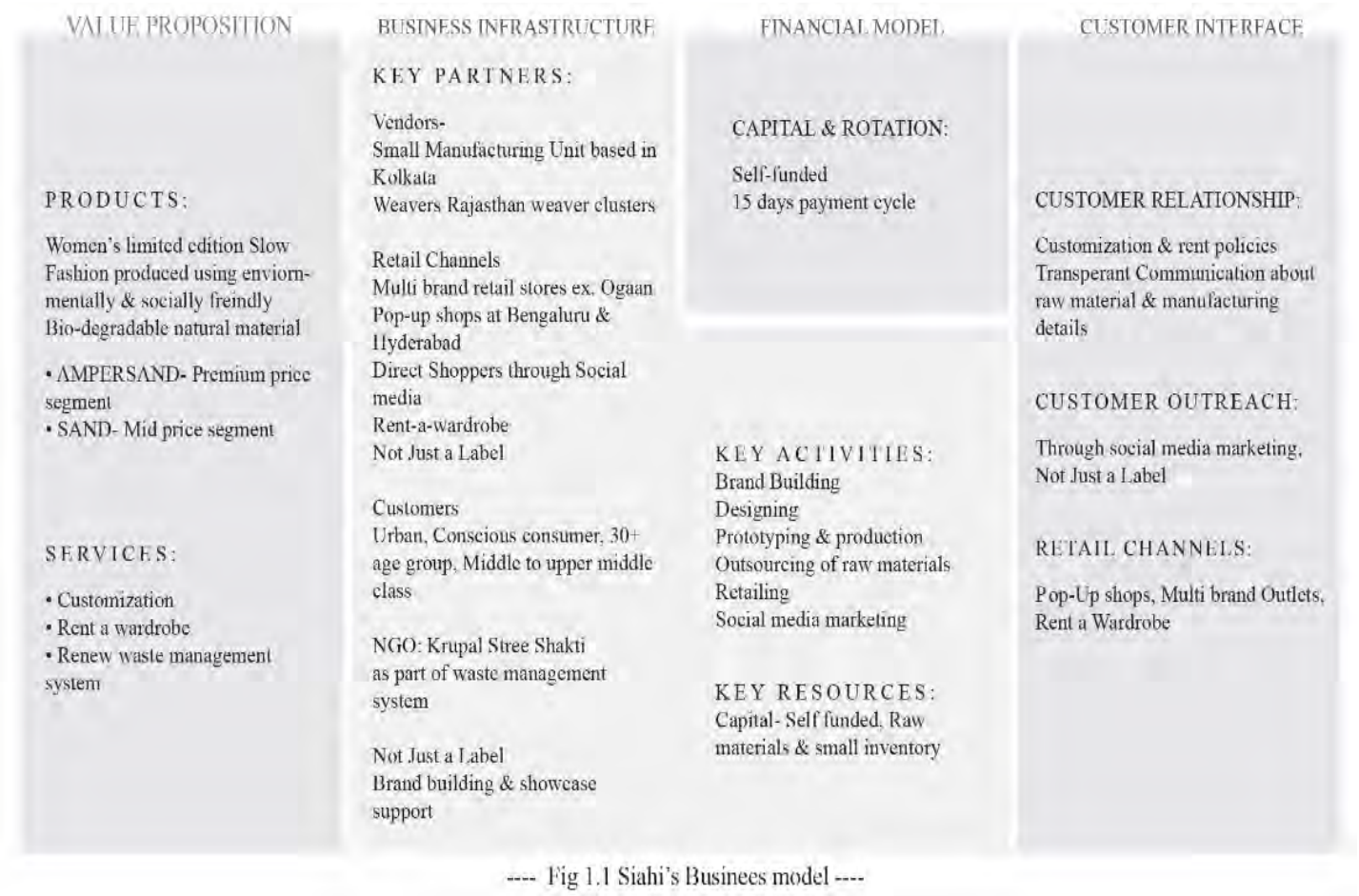
1. INTRODUCTION

AMPERSAND, was launched in 2017, out of the Assamese hill city, Guwahati, the gateway to idyllic lush green North-east of India by Ms. Priyansha Mehra, a fashion business graduate of National Institute of Fashion Technology. Inspired by the lifestyle of Assamese & Rajasthan's villages and small towns, Priyansha, continuously questions the need for scaling up a business by increasing inventory and blindly following seasons. Her design process is rooted in reacting to the actual needs of a customer by customization & designing with an occasion in mind. Priyansha's fashion journey exposed her to the perils of fast fashion inventory & advantages of social media marketing inspiring her to create AMPERSAND. Her experience of working in India taught her that the real Indian challenge is to create a sustainable line that's affordable for a developing, diverse & price sensitive country. Indian customer desires sustainability but at affordable prices, led by this she created 2 slow fashion brands AMPERSAND & SAND under Siahi. (Mehra, n.d.)

AMPERSAND is a mid- priced to premium slow fashion brand for a woman for whom her style is an expression of her own personality, someone who enjoys fashion but does not let the trends dictate her wardrobe. The brand creates sustainable pieces of limited and unique edition, that use hand-woven fabrics and hand embroideries. Ampersand, believes that nature is the ultimate luxury and design should strike a balance between beauty & good intentions.(Mehra, n.d.)

SAND on the other hand works with the mantra of Renewing by providing more economical yet environmentally sustainable products for the customer's day to day needs, by repurposing raw material waste created by AMPERSAND. Both the brands work together, in a proactive manner, using waste reduction methods with an aim to increase economic viability along with increasing environmental sustainability.

Analysis of Siahi's business model: Siahi's business model & its constituents are discussed below, providing the rationale defining how the organization creates, aids & delivers. Figure 1.1, has been used to give an overview of the 4 pillars of the business (Lüdeke-Freund, 2010)



---- Fig 1.1 Siahi's Businees model ----

Pillar 1 Value proposition: Products & Services (refer fig 1.1): The brands produce slow fashion items in the range of INR 2500-8,000. The looks are customized fusion of western outfits using Indian fabrics & traditionally inspired motifs. Offering a mix of dresses, tops, jumpsuits & bottoms in urban chic or holiday looks. Approximately 80% of the material used is natural & Bio-degradable sourced from Artisans & Weavers. Customization, Renting & Renewing, are the services that Siahi offers, through simple processes & collaborations, illustrated in fig 1.2. The brands work through customization model and a close circuit of vendors who are willing to work at short notice and for small orders, the complete product cycle from order to delivery is completed in 4-10 days. The company has recently tied up with a rent-a-wardrobe service provider,

where stocks can be rented till the natural wear & tear takes place. Receiving 8% of the MRP for each rent. The company plans to take the association as a way of handling inventory & rotating it to maximum use. Siahi follows 2 methodologies as part of its 'renew initiative' with the ideology that any scrap more than 10 cm will be salvaged. SAND, is produced using mostly leftover raw material stocks of AMPERSAND. Fabric Scraps are used as much as possible for small patches, fabric covered buttons, etc. SAND's product line is also completely customizable, is more affordable. Siahi has collaborated with an NGO (Dimopoulos, 2020-01-20)to create small pouches & diaries out of raw material scraps.

Pillar 2- Key Business infrastructure Constituents: Siahi's business model falls under sole-proprietorship running on outsourcing with an aim to utilize the best skill set available using least amount of working capital. It works with limited capital & resources with 100% outsourcing of manufacturing processes and are mainly, small inventory & raw material stocks, held at the manufacturing unit. Brand building activities involve collaborating with 'Not Just A Label' platform and Social media marketing activities majorly on Instagram. All design activities are conducted by Priyansha herself, out of her home office in Guwahati. Her design process starts with researching on consumer need & directly catering to it in season less collections. Sampling & Production are outsourced with a small manufacturing Unit based out of West Bengal. The textiles are mostly handlooms, sourced directly from weavers based out of Rajasthan & Assam, avoiding the middle men margins costing in the range of Rs 195- 500. Direct sourcing also helps in establishing authenticity of the raw material used as well creates direct business and employment opportunities for the marginalized weaver communities.

Pillar 3Financial model (refer fig 1.1): Siahi, is currently self-funded and is able to cover all its expenses through its Gross margin ranging between 20-25% with Operating profit margin as 0-5%. But is not able to pay the proprietor salary or employ a human resource or generate net profit. With INR 1,00,000 (approx..) on a monthly basis. The sale is mostly seasonal & higher in the months of September- January & June-July, capturing festive, party & holiday business.

Pillar 4Customer interface (refer fig 1.1): Due to customization service, there has not been any return in Siahi's experience and hence no need to develop an exchange policy. The packaging is minimal & reusable, and without using poly bags. The packages are shipped in plastic boxes that can be reused up to 40 times, or, in case of small orders are shipped in muslin bags boxed in small cartons, these bags are also reusable & washable. Retailing activities are handled by Priyansha herself and done through 6 Multi Brand Outlets (Chennai, Hyderabad, Varanasi, Bangalore, Surat & Singapore), Pop-up shops (Bengaluru & Singapore) & Direct shopping through Social media mainly Instagram & Facebook.

External Growth Barriers: The sustainability challenge is resultant of lack of cohesive collaboration from 3 pillars of the industry, government policy making, retail & innovation (Gjerdrum Pedersen, (2014)). Indian government has not run any large-scale campaigns sensitizing the industry & consumer about perils of fashion industry. This can be disruptive but will also increase opportunities & investments for sustainable businesses. Indian market is a price conscious consumer market and customers are not willing to pay a premium price for sustainable product. The retail margins are too high & sustainable businesses do not get any relief. Moreover, the current Indian fashion houses/ brands are mostly based on 'revive & conserve' policy of traditional textiles with minimal focus on innovation.

Internal Growth Barriers: Siahi, has not adequately used the sensitive and dynamic social media platform to adequately convey its sustainability message and hence is not able to get conversions from likes to sale. Further aggravated by absence of a social media shop. The brand needs to expand its customer & retail interface which is very limited, mainly due to a seasonal product line focusing only on fashion & not essentials or core. Currently retail margins in India range between 35-40% and do not offer Margin discount for sustainability. Siahi, has been unable to increase the business scale (without altering the business constituents)as the current is too low to qualify as an investment opportunity and its investment in marketing & PR is very low. It is yet to explore government support, provided by Ministry of textiles, Ministry of Micro small & medium enterprises, Startup India, Incubation center, academic institutions, etc in terms of funds, loans, knowledge expansion for women and North-east entrepreneurs.

Siahi's sustainable targets: Siahi, aims to continue on the sustainability path with 3 main focuses, which are described below in table 1.2.

	Current	2-year Targets	5-year Targets
Sale in INR	Monthly sales > 1,00,000	Monthly Sales >20,00,000	Monthly Sales >20,00,000
Economic Sustainability	Retail Consultant to expand retail presence; Launch of Social media Shop; International presence through more retail stores & pop-up shops; Ensure sustainability message reaches the customer; Expand product line to create sustainable Home line	Seek investments; Launch of brand's shopping website	Create Pan-India reach
Environmental sustainability	60% sustainable raw material, 80% business in circular model	Using at least 80% sustainable raw materials, 20% regular colors replaced with natural colors	100% business in circular model, 100% regular colors replaced with natural colors
Social Sustainability	Collaboration with NGO	At least 1 fair trade collaborator; Develop more multi-sector collaborator	50% collaborators practicing fair trade

2. CONCLUSION

After detailed analysis of Siahi's business model, following conclusions can be derived. Siahi, has not achieved financial viability yet, but has not wavered from its core brand value and has moved in leaps & bounds to develop product line & processes that are environmentally & socially sustainable.

---- Figure 1.3 Siahi's Circular Business constituants ----

Environmentally Sustainable Practices- Environmental Sustainability, has been at the core of Siahi's business model since its inception. Recycling, upcycling, renting, customization all work within waste management systems along with using environmentally friendly raw material. Currently 60% of its products are made using handloom fabrics, directly from artisans, establishing the authenticity of resources being natural & bio-degradable. AMPERSAND & SAND's customization service, also becomes part of waste management system by keeping the inventory low. SAND, collaborations with NGO Prukal Stree Shakti & Rent-a-wardrobe collaboration, work together under 'Renewed' policy using left over stocks as well as scraps, making Siahi's business circular resulting in Zero waste(Jørgensen, 2018). Illustrated in figure 1.3.

Socially sustainable Practices- Siahi's business as well as sourcing, all are based away from India's busy metropolitans and hence contribute in creating employment opportunities in the rural or semi-urban areas, without contributing to any kind of pollution or working condition issues. The weaver clusters & the NGO mostly employ large number of women, giving them an opportunity to be economically independent. Small productions, no minimum orders have strengthened the Slow fashion ideology. Hence, it can be concluded that the current business model does not create social tensions between collaborators and is much more forgiving & runs with mutual respect and acceptance.

Recommendations: Siahi's economic challenges must be tackled on a priority basis, as the business is already in its 3rd year from conception. The challenges & issues though urgent, can still be tackled in some simple ways showing immediate results. The current economic targets mentioned in the table 1.2 can gain better output

with some more actions & collaborations as recommended below.

1. Funds can be pushed in the business through government collateral free loans or private investments through incubation centers.

2. Product margins& sales can be improved by increasing the percentage of Direct shoppers and saving on large retail margins and exploring exports market. This can be done by connecting the social media marketing with a social media shop.

3. Siahi can gain from collaborating with Academic institutions on developing Business Strategy, Design Strategy, Research & Innovations.

4. Improve marketing & retail communications using marketing ideas such as Vocal for Local, Kind Craft, Virtual party, Work from home, Longer product life, etc. Social media communication can also establish its already existing connection with United nations Sustainable development Goals (Unicef, n.d.). Labels can be used to communicate & authentically establish the sustainable aspects of the brand. The brand can launch 'Pre-order' service to avoid losing business due to 4-10 days delivery schedule, when a garment needs to be built from scratch for a customer.

5. Season less & essential products should be added to increase volume, which may be preferred more by the customers due to the economic downturn and work from home needs.

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I would like to extend deep acknowledgment to Ms. Priyansha Mehra, who was completely forthcoming in sharing insights about her journey, coming across as an enthusiastic learner & knowledge sharer along with being a sustainable fashion warrior.

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TECHNICAL SESSION III
FASHION AND TEXTILES: PERSPECTIVE ON INNOVATIONS

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UV-protected & Thermal Controllable Nano-particle Treated Home Furnished Woven Fabric

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ABSTRACT

The home textiles market is renowned as a very fundamental and crucial segment in technical textile segment and it can readily transform your home into a fantastic and enjoyable ambience. The pattern, size and design or styling can change the look for any house. Recently, many new innovative techniques like- Thermolite fabrics and Coolmax bed sheet, smart carpets, sensible thermo-regulating dyed curtains, solution dyed acrylic or polyester fiber based UV protective bed sheet or curtains and artificial intelligence based home furnishing materials has been introduced in the market. These products are relatively costly to comply with their objectives. In this current work, we have proposed a nano-zinc oxide and titanium oxide mixture processed based disperse dyeing on polyester/cotton blended home furnishing materials to make them highly ultraviolet (UV)-ray protective, high pollution resistant and also cost-effective at the same time. The process is also been validated with various tests like environmental pollution analysis, thermal behavior analysis, K/S value, dye pick ratio, light, color and washing fastness etc.

Keywords: Home furnishing; Nano-zinc oxide and titanium oxide; K/S value; Environmental pollution analysis; Cost-effective

1. INTRODUCTION

Textiles have been used in our daily life for centuries. The most obvious use is in clothes, but domestic cloths (e.g. rugs, table cloths, drapes, provide coverings and bed sheets) are also a enormous application place for textiles. Though textiles have lots of great properties, they have some less desirable properties. To enhance the properties different tactics to modify the textiles have been invented, as well as fresh raw materials and fabrication methods for cloth production, as is the case with most synthetic fabrics (Rebelo et al., 2016, Wang et al., 2008).

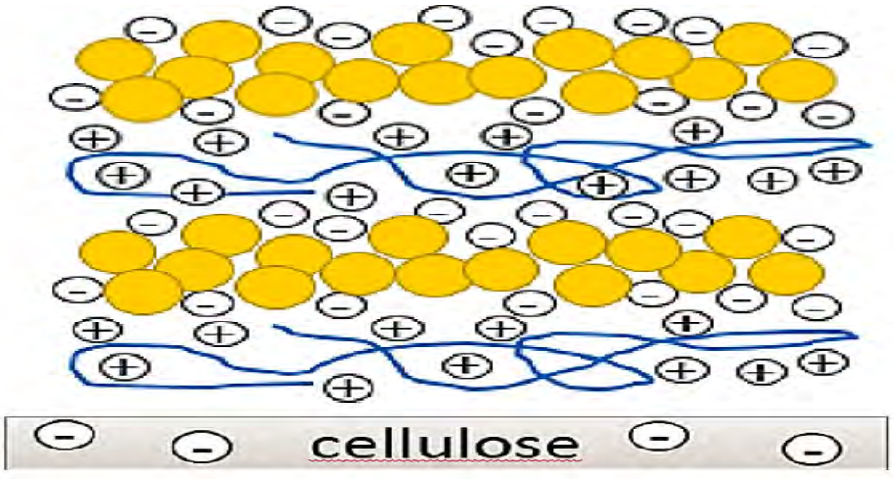


Fig. 1. The PLL accumulation; nano carbon nano mixture of Zno along with TiO_2 that the Bilayers consist of layer of positively charged polymer and a layer of negatively charged particles (Zhang et al., 2007).

2. MATERIAL USED

100% combed Cotton knit fabric (single jersey, 20 therefore Ne, epi/ppi 50/32) was procured from Nahar Industries Ltd., Ludhiana, Punjab, has been used to carry out this study. We have used 1-5 percent add-on of octadecylaminomethyl triethylhyhdroxysilylpropyl ammonium chloride, 1 to 2% add of silver chloride based compound, silver chloride in alumino silicate carrier base, 1 to 5% addition of polyhexamethylene biguanide are implemented onto the fabric substrate by spraying process at moderately acidic condition followed by heat treatment polymerization in between 130° C. and 160° C., that elevates antimicrobial property to textile substrate across the whole cross section which displays disinfectant like properties combined with mildly hydrophobic performance, 5 to 20 gm/lit of blocked isocyanate based thermoplastic polymer dispersion and 1 to 20 gm/lit thiabendazole, 5 to 20 gm/lit of poly-glucosamine oligosac chloride are implemented onto the preceding antimicrobially treated cloth substrate at between 120° C. and 150° C., which has bonded to the fabric substrate from either side and generates the reactant moiety to other functionality finishes (Ariga et al., 2014; Li et al., 2016).

3. UV AND TESTING

- **QCM-D**

In QCM-D, a little quartz crystal is oscillating during its resonance frequency when the nanopartticles are adsorbed onto the crystal, the oscillation frequency decreases, and the adsorbed mass could be computed from this change in frequency. Similarly, when something is desorbed, the frequency increases. Therefore, the adsorption (or desorption) process can be tracked in real-time. The dissipation, energy losses due to friction can be tracked. This provides information about the viscoelastic properties of the adsorbed layer (Paladini, et al., 2015, 2016, Richardson et al., 2016).

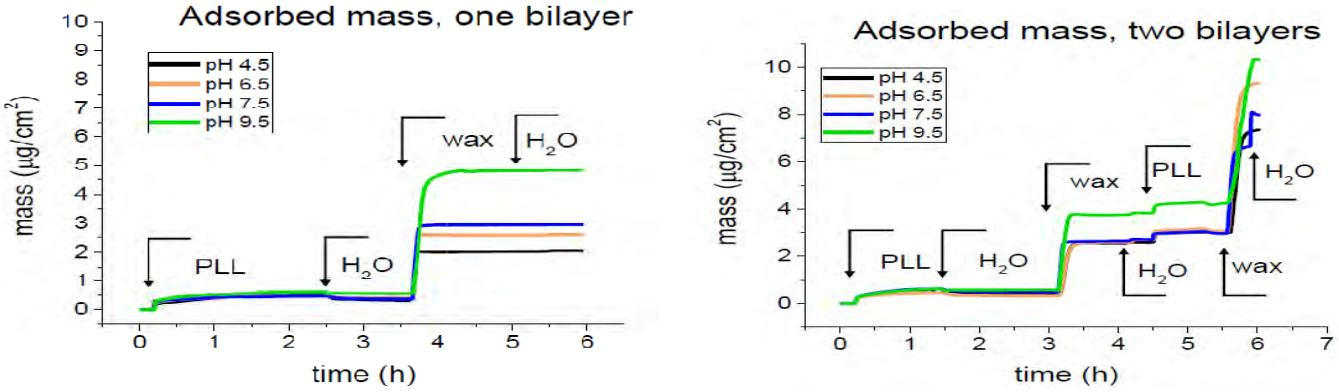
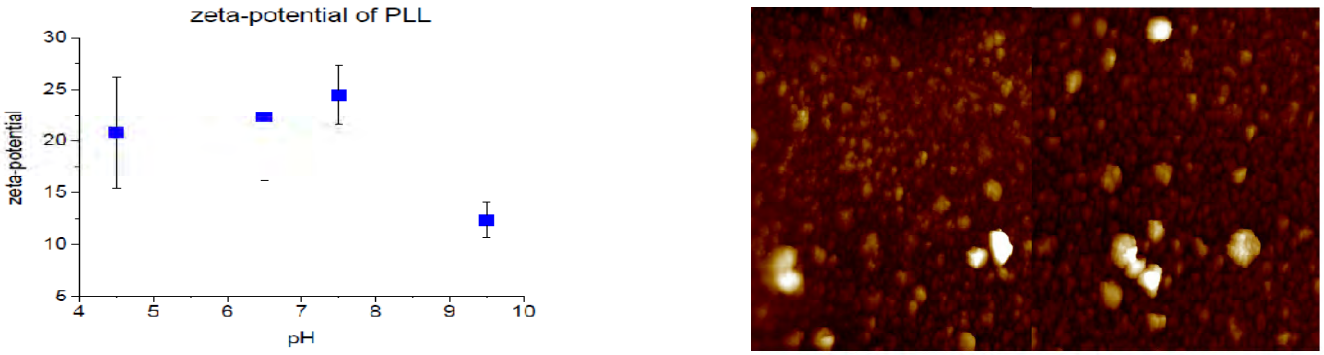


Fig. 2. The adsorbed mass-produced using for one bilayer of PLL (partial Lipid coating) and wax.

- **Zeta potential value & Atomic Force Microscopy (AFM)**



(a) **(b)**

Fig. 3. (a) The Zeta-potential of PLL at different pH (best outcome at pH 9.5) (b) AFM height Images of PLL-wax two bilayers at pH 9.5 5µm (nanomixture of Zno and TiO_2 depositions were revealed as drops that were white).

- **Contact angle (CA)**

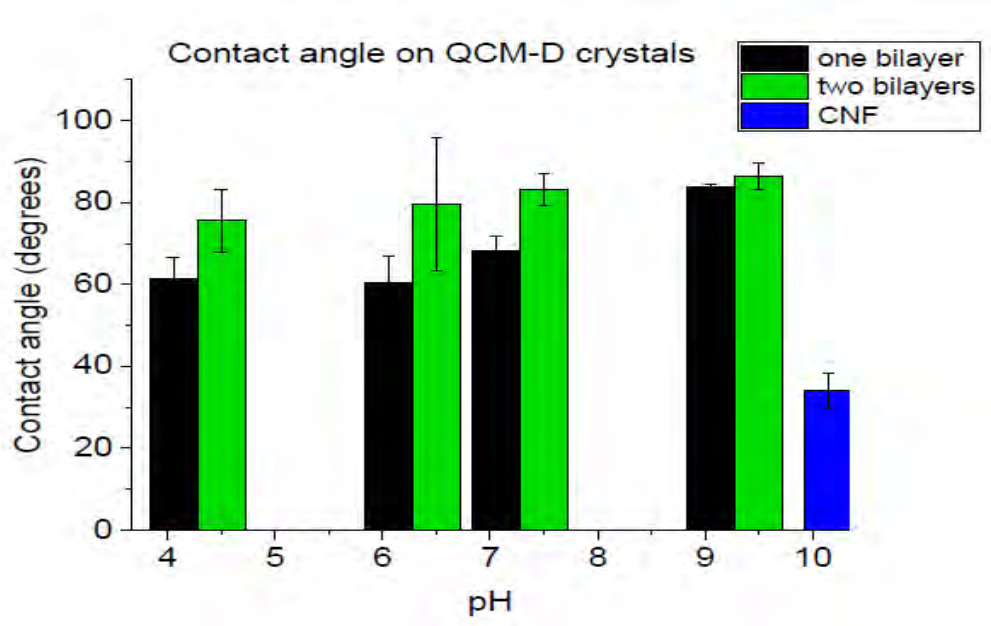


Fig. 4. The CA of PLL-wax a single bilayer and two bilayers, based on pH of PLL; CNF (Carbon nanomixture of Zno and TiO_2) is an uncoated reference. Five measurements were conducted on each individual sample.

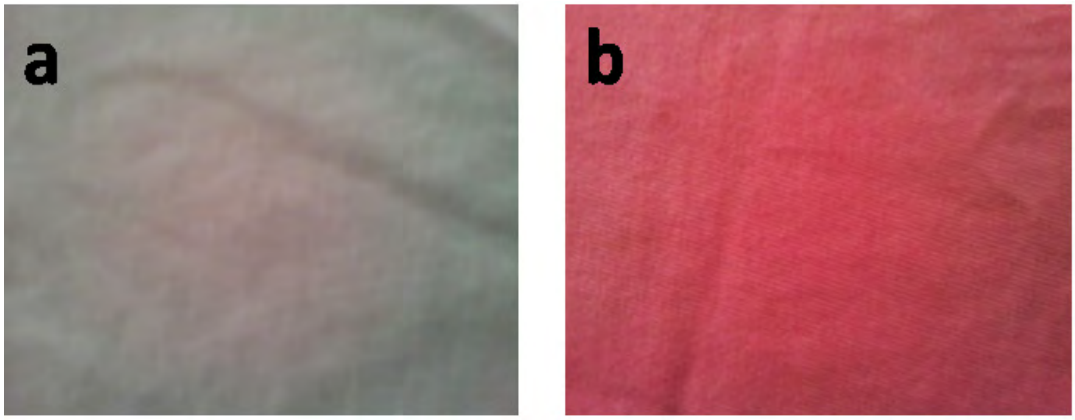


Fig. 5. (a) Grey nanomixtured treated fabric (b) dyed with reactive dyed cotton fabric at 0.5%

4. CONCLUSIONS

Nanotreated UV and as well as thermally controllable woven fabrics can be suitably used for various purpose united with breathability and wonderful appearance (Xi et al, 2008). These modification/manufacturing techniques that produce breathable yet UV-protective fabrics incorporate microporous and hydrophilic solids and solids or a combo of the two, as well as the use of retro reflective micro beads.

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Subjective Assessment of Clothing Fit of Ready to Wear Apparels amongst Transwomen

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ABSTRACT

Clothing fit ensures human body comfort in terms of microclimate, movements and the body well-being. It has long been regarded as the single most important element to customers in clothing appearance. Garments produced in serial production developed according sizing chart, which is suited to the individual measurements by indifference intervals only. Confidence and comfort of the wearer depends on the fit in a garment. This paper documents the subjective assessment of the apparel fit amongst transwomen and identify the clothing fit satisfaction level towards ready to wear clothing by the transwomen in conjunction with the issues related to the apparel fit based on the anthropometric measurements. Using snowball technique a sample of forty transwomen from Delhi NCR would be analyzed using questionnaire as a research instrument with scales assessing fit preference, body type and consumer demographics. Findings from this research inferred the designers and manufacturers to understand the fit issues and reassess their methods relative to the consumer group who wish to serve this niche market.

1. INTRODUCTION

Fit is an important criteria in apparels because it is directly related to the physical comfort of the wearer as well as the clothed body viewed by the public. Although consumer's dissatisfaction with fit has a negative impact on purchasing decisions as meeting the needs of every person in terms of fit preference is difficult for apparel companies as ready-to-wear clothes are made for consumers with normatively proportioned bodies and for the mass production. Well-fitted garments are defined as those that are comfortable to wear, allow sufficient ease for freedom of movement, conform to present day fashion and are also free of wrinkles, sags or bulges (Madhu, 2002). From the consumer's point of view, the 'Fit' of the clothing is the most important attribute and how it conforms to the body structure. The desired fit in clothing changes with fashion (Lupo, 1987). Fit and com- fort are the prime features a consumer looks for in clothing. Fit is a specific attribute that depends on the wearer. A garment either fits or does not fit a particular wearer (Ryan, 1966).

According to 2011 census, 4,87,803 lakhs are been classified as transgender out of which 54854 is below 6 yrs. and literacy rate is 56.07%. Maximum number of concentration are found in Uttar Pradesh and Maharashtra consisting of 28 and 8% respectively. (Census, 2011).

2. PURPOSE OF THE STUDY

The research paper mainly focused to find out the problems faced by transwomen in ready-to-wear garments from the age groups of 18-40 years and to access the preference of transwomen consumers towards women's western ready-to-wear garments.

3. LIMITATION OF THE STUDY

1. The study is limited to the women's western wear which includes close fitted gowns and dresses.
2. The respondents for the study were transwomen in age group between the 18-40 years.
3. The study was conducted in Delhi NCR.

4. METHODOLOGY

Locale of the study: The study was conducted within the Delhi NCR city with the method of random sampling in area sampling.

Sample size: The total sample size of the respondents was taken as 40.

Sample selection: The research was done by selection of Multi-stage sampling method in which consumer

survey was conducted with random sampling in area sampling.

Data Collection: Both the primary and secondary data collection methods were considered. The primary data was collected through a questionnaire designed exclusively for the study. The secondary data was collected through journals, articles, and internet.

Analysis of Data and Interpretation: After the collection of the desirable data through questionnaire, the data was be analyzed and the final result was evaluated through the transferring the data to the excel sheet. Then the data was evaluated by putting the desirable and suitable tests.

5. RESULTS AND DISCUSSION

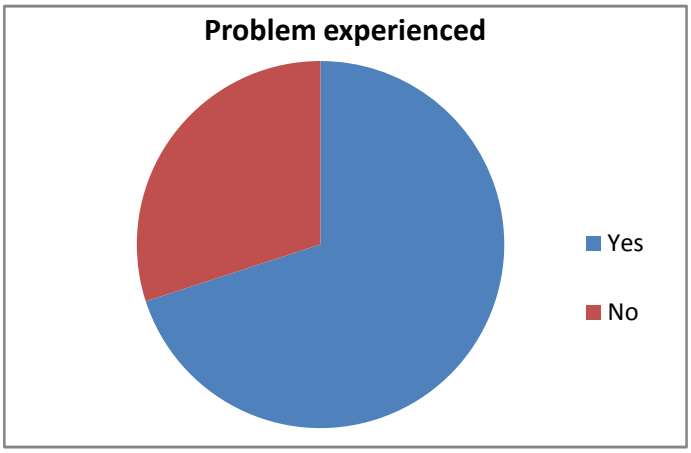

Fig. 1. Fit problems experienced by purchasing Ready-to-Wear clothing. n=40

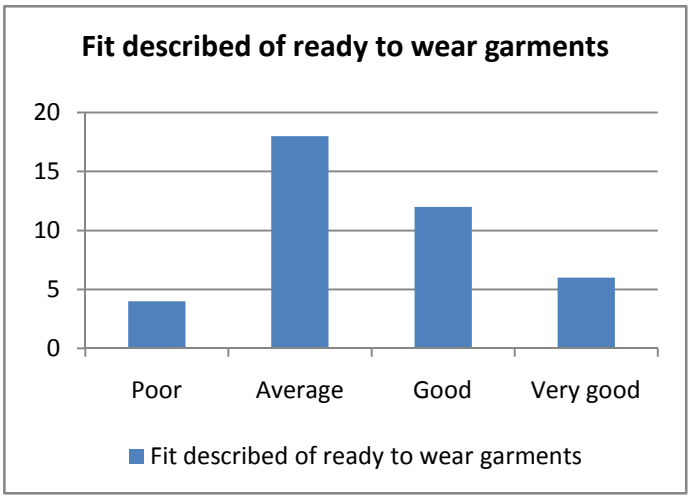

Fig. 2. Fit of close fitted Ready-to-Wear garments N=40

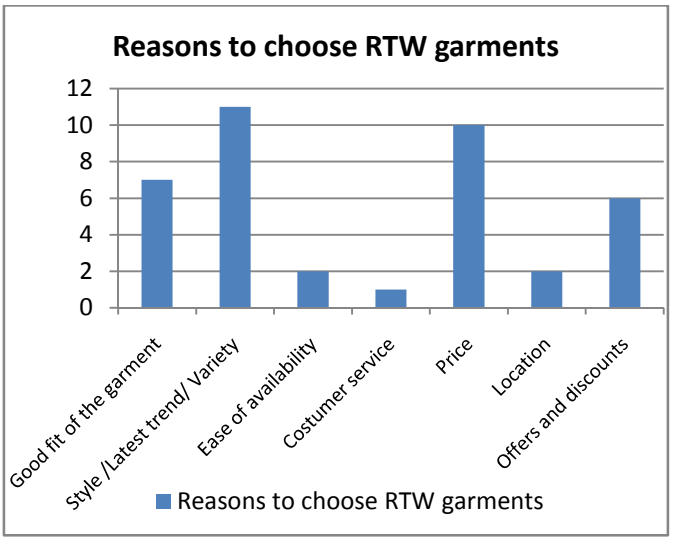

Fig. 3. Reasons for preferring Ready-to-Wear garments N=40

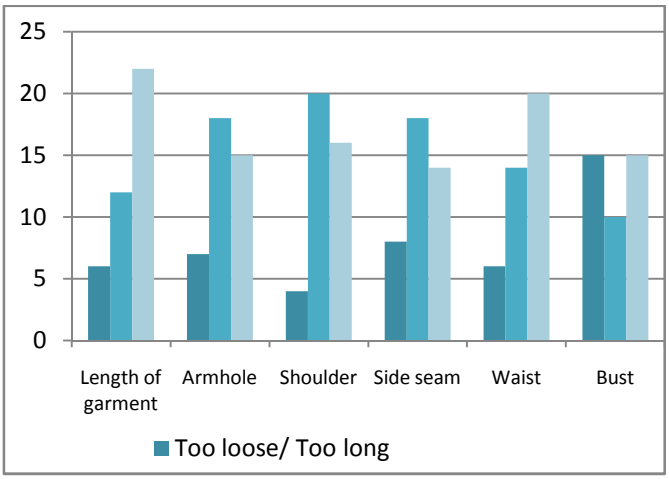

Fig. 4. Problems faced in various areas by consumers with the fitting of ready-to-wear garments (Upper wear) N=40

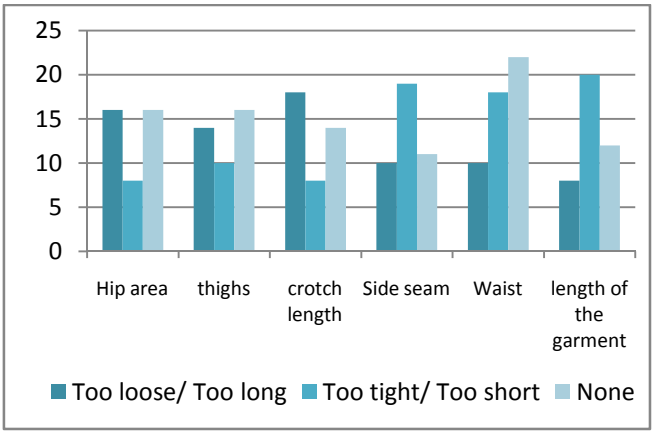

Fig. 5. Problems faced in various areas by consumers with the fitting of upper ready-to-wear garments (Bottom wear): N=40

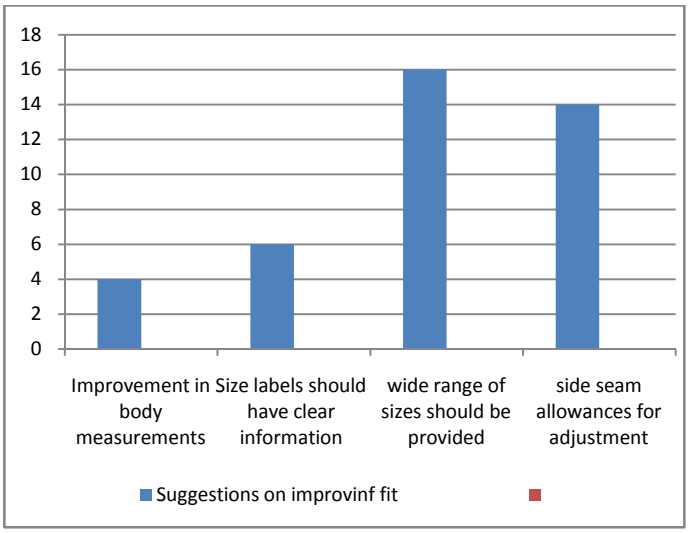

Fig. 6. Suggestion on improving fit of ready-to-wear-garments: N= 40

6. SUMMARY AND CONCLUSION

The study was conducted to identify the fitting problems faced by transwomen in ready-to- wear upper garments. The study reveals that the transwomen are concerned about the fit most of the times in close fitted ready-to-wear garments and they have mostly experienced fit problems with purchase of their garments. The majority of transwomen described fit of ready-to-wear garments as average. The study also indicates the reasons for choosing ready-to-wear garments. The three major reasons are good fit of the garment, style/latest trend/ variety and price. The study further reveals that the transwomen experienced fit problems in areas around shoulders, bust and waist in upper wears and around hip and thighs in bottom wears. The consumers have also suggested improvements in fit by various factors, in which the majority suggested that the wide range of sizes should be provided.

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Clothing Comfort Research Studies: Scope and Challenges

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ABSTRACT

This paper discusses need and continued requirement of extensive research in the field of clothing comfort. Categories of comfort are briefly discussed and multidisciplinary nature of the field is mentioned. Reasons of possible errors and inaccuracy in studies along with future scope for research is described. The comfort expectations from clothing have been enhanced multi fold in last few decades, especially in case of functional fabrics and clothing it has become very significant. The elements of textiles which form comfort of clothing need to be studied well and manufactures are required to implement this knowledge to produce clothing. A continued effort from research fraternity is also found working on all aspects of clothing comfort and many activities are found taking place all over the globe. Present paper is an overview of research in the field of clothing comfort.

Keywords: Clothing comfort, objective testing, patents, subjective scales, research

1. INTRODUCTION

Clothing is the basic need of civilized humankind and clothing comfort is an integral part of any clothing system that allows a wearer to perform his activities without clothing distress. Clothing comfort is a relatively new field of study. Clothing comfort is categorized into physiological, tactile, ergonomic, and psychological comfort. This paper discusses different aspects of clothing comfort research and the scope of future work in different segments of clothing comfort. The clothing comfort is studied in three categories, physiological, psychological, and ergonomic. The physiological comfort is associated with transmittance and tactile properties of clothing while ergonomic comfort is largely governed by the fit and style of the garment along with the type and location of accessories' use in garments. The psychological comfort may vary among individuals and it is not covered in this paper because of numerous subjective and abstract factors that are not directly related to textile material and associated process parameters. Clothing comfort has been the interest of scholars since 1930 when Pierce shared his study on handle properties of clothing and some other texts on clothing were published in different parts of the world. Since then, scholars are working to enhance knowledge repository related to clothing comfort, this paper mainly includes scholar work in the last decade. US patent website shows many patents related to clothing comfort, most of the patents are on a specific type of clothing, among these patents, clothing comfort is the highlight factor. Apart from clothing, there are many patents of different measurement instruments that are used in the field of clothing comfort studies. The Central Government is empowered to form rules and implementing the Act and regulating patent administration Under the provisions of section 159 of the Patents Act, 1970,which has been time to time amended and last amendment was made in 2006.This is governed by the Ministry of Commerce and Industry of Government of India. The patent India website shows 1978 patents for keyword textile and 552 for word clothing. These numbers suggest activities involving creativity as a result of research associated with different aspects of textiles and apparel including clothing comfort. However, all patents are not directly related to clothing comfort and it also suggests scope for creations on clothing comfort getting patented. Google patent search engine shows a giant number 83721 when clothing comfort is searched, this number itself explains clothing comfort has intellectual creativity along with a utility to everyone being the end-user of clothing.

Agencies and organizations: Globally research centres, universities, and educational organizations are involved in studies related to clothing comfort. At some universities, textile and mechanical studies are

performed under one department. All textile research centres in India and abroad are working actively to explore knowledge and putting their efforts to make objective testing for clothing comfort more accurate and economic. "ASHRAE" is the American Society of Heating, Refrigerating and Air-Conditioning Engineers has published some very useful literature that relates to clothing comfort. The International Conference on Environmental Ergonomics (ICEE) is a regular activity which takes place once in two years, the first conference was held in 1986. The proceedings of held conferences have papers related to clothing comfort.

2. DISCUSSION

It has been multidirectional development in the field of clothing comfort research, definition and related terminology are the theoretical base of understanding associated features which have universal acceptance among the scholar fraternity. Among all three categories, physiological comfort can be acquired by using material of certain tactile and transmittance properties and ergonomic comfort may be acquired by the use of suitable interface characteristics in the garment (Das, A. & Alagirusamy, R2010). It is found that the availability of comfort studies is more on cold climate and weather conditions than hot climate and weather conditions (Foster J. et al. 2020). A system needs to be developed such that quantification of comfort quality is universally accepted. Scales for accessing the comfort perception of individuals can be developed for climate and weather conditions. The clothing system is required to protect the human body from extreme weather conditions and allow the wearer to perform required activities without creating hindrances. The clothing comfort though studied in three categories but for the wearer, it is not separated by its category a wearer generally perceives a clothing system either comfortable, not so comfortable, or uncomfortable.

Comfort properties for different textile raw materials have been studied by different scholars. Comfort characteristics are found associated with the properties of fiber, yarn, and fabric. The yarns spun by a different spinning process, ring, rotor, and friction do affect the comfort characteristics of fabrics woven by those yarns. (Behera et al. 1997). Studies are conducted on natural fibres like linen, cotton, wool, etc., scholar studies are available on clothing comfort of different synthetic fibres as well as blends. Apart from conventional fibres and blends some fabrics were made with the use of new unconventional fibres and their comfort properties are studied. New textile materials are also experimented for their comfort characteristics (P. Verduet al. 2009). The importance of fit has been acknowledged for functional and it is accepted that proper fit enables better performance (Lyn, 2011).

Instruments for the objective test: Comfort is largely a qualitative phenomenon but many factors that form clothing comfort are quantifiable. Engineers and scholars have been quite active in developing instruments that can measure properties that form clothing comfort. In the beginning, most of the instruments were mechanical with the time they evolved and now mostly instruments make use of electronic components. Many instruments can measure air permeability, moisture vapour transmission, thermal conductivity, etc. apart from these mentioned transmittance properties few instruments can test the tactile properties of fabrics. The instruments for tactile properties measurements are very few and very costly. There is a wide scope for the development of instruments that can measure properties that decide the level of comfort. The instrument should be accurate, easy to use, and universally effective. There are various instruments to test comfort characteristics mainly two popular systems for comfort evaluation are prevailing one is from KAWABATA another is FAST.KAWABATA is a system of different testing instruments while FAST stands for Fabric Assurance by Simple Testing. Apart from testing instruments and testing some devices have been developed to test comfort parameters. Sweating and moving arm for the measurement of thermal insulation and water vapour resistance of clothing, was used in 1996 (Weder et al.), and manikins have also been used for deciding different standards for clothing comfort (US Patent, US6543657B2).

Input from other fields: Some scholars from the medical and environment field contribute to the clothing comfort. This is established that having proper thermal comfort from clothing external need for cooling or heating is reduced and this leads to conserving energy (Butera,1988) (Zhao W et al.2019). Scholar work by environment experts has helped in developing different thermal sensation scales. Medical experts provide inputs in many ways, skin being the largest organ of the human body, some very significant piece of tactile comfort-related information comes from the medical field. Smart clothing makes use of different electronic devices with a high degree of precision. Clothing being a consumer

item feedback from management and marketing people for product comfort also plays a significant role. The concept of comfort applies to all fields wherever the human interface is involved. All the segments of human life where textile materials are used comfort features are given serious consideration. Comfort properties of the grip of racquets in different sports like badminton, squash, seat covers of different seats in home furnishings, wheelchairs, automobiles, etc are an example of few examples where the concept of clothing comfort is applied. A study suggests clothing comfort as a necessity for inmates (Antonucc, 2016).

Scales for the level of comfort: Various scales are used to study sensations on touch and thermal comfort. The Mc Ginnis' Thermal Scale is one of the popular scales, thermal comfort can be studied with the help of the following type of rating scale: (i) Thermal sensation scale (ii) Thermal preference scale (iii) Thermal comfort scale (iv) Thermal acceptance scale. The comfort sensations are recorded mainly with the help of ordinal scales, these ordinal scales use different phrases as per the target of the study. The data collected with the help of these scales are statistically processed and give quantifiable information related to comfort.

Limitations: The impact of environmental variables, and emotional factors are very hard to include in studies. Simulation of real-life situations in which a clothing will be worn is very difficult to achieve and maintain. A lack of consistency in measurement of comfort in subjective study is a problem, this may be assigned to emotional or physical state of the subject. The researchers used a wide range of different scales and tools this further leads to an issue related to absence of universality.

Future scope: 1. Textile raw material and finishes are developing, globally with changing requirements as well as the availability of different resources. Clothing made by new material and applied with new finishes will be studied by scholars for comfort characteristics.

2. Modern-day technology is applied in constructing a different type of smart clothing, these clothing also need to be comfortable like any other clothing however requirement of comfort-related characteristics may differ in magnitude. Hence the development of smart clothing and their comfort measurement methods have a vast scope of development.

3. Clothing comfort studies help manufacturers to develop new material and process, it also suggests to change existing parameters to attain better comfort properties in the product. This is a continuous process, so is the need for research in the field of clothing comfort.

4. Clothing designs are always under some changes; these changes will attract scholars to pursue studies on ergonomic features of new designs' clothing. The ergonomics of clothing is an integral part of clothing comfort and for functional garments it becomes crucial.

5. Clothing comfort involves an enormous number of dynamic factors some are intrinsic to clothing some are related to the environment in which clothing is worn, this will keep scholars engaged in exploring characteristics of clothing comfort in different situations for the different wearer.

3. CONCLUSION

Every aspect of clothing has its influence on clothing comfort, it includes, type of fiber, yarn, fabric, and garment related factors. This fact is significant that things are not just black and white, there are many greys as well, one factor that contributes to comfort on one feature may adversely affect another comfort feature, here the researchers have the responsibility to evaluate the extent of the effect so that the trade-off can be decided accordingly. The research in the field of clothing comfort has come a long way and many mile stones have been achieved, with the advent of new material and ever-changing world the need will remain for research in the field of clothing comfort to make the life of human kind easier.

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Smart Textile Chemical Processing (Cotton Dyeing) Plant: Challenges & Opportunities

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ABSTRACT

A modern smart fully amalgated textile cotton dyeing factory is the need of era. The sustainability within the field of chemical textile processing coloration industry, especially in dyeing of cotton is by and large the function of industry 4.0. The fourth technological revolution or Industry 4.0 has remarkable impact on coloration industry, which is the backbone of any apparel, fashion textile industry. A sensible fully integrating smart dyeing plant will utilized the revolutionary leading edge technologies viz. AI, IIOT, machine learning automation, web based data analysis, robotics and sensors for predictive analysis, self-diagnostics corrections, auto optimizations for levelled shades, maximum efficiency with minimum water load and price . The 4.0 Coloration industry based dyeing factory will integrate all the newest tools of AI, machine learning, large data analysis in one hand and enzymatic also other green energy efficient coloration technology on other. This present study is proposed to develop a module on the challenges and opportunities for a latest coloration industry 4.0.

Keywords: Artificial intelligence, 4.0 Coloration, machine learning, IIOT, enzymatic dyeing.

1. INTRODUCTION

Color is a particularly important aspect of textile materials. Dyeing is that the application of color to a textile material with a point of aesthetics, consistency and fastness. The materials which impart the colour are referred to as colorants. When these colorants have a natural affinity and permanence on textiles, they're mentioned as dyes. Dyes actually migrate or diffuse into the chemical molecular structure of textile fibers so as to develop the ultimate color of the textile product. The dye-fiber molecular association is additionally liable for the degree of fastness or permanence of the colour due to the molecular attraction between the precise dye and therefore the specific textile fiber; dyes are classified as being fiber specific. That is, dyes which work on cotton may do not work on polyester, nylon, acrylic, wool and lots of other commonly used textile fibers. When we visualize smart dye house we mean, all the major dyeing and processing machines working in the plant are enabled to communicate among them self through information system network. It utilizes big data analytics and artificial intelligent technology. Fong has developed automated solution of package dyeing for cotton and other important operations. Smart Automation includes the web of Things and a spread of operations which may operate using some quite local intelligence and communication. This facility can make dyeing operation simple, efficient and enable for real time performances. It can avoid many routine anxiety situations and should eliminate wastages, utitilise enzymatic dyeing solutions, labour problems, power wastage, and safety and security issues. Smart Apps notifications provisions cause improvement in productivity also as responsiveness. One central point monitoring system manages the operating schedules, working hours, its operating parameters viz. time temperature pressure etc. collectively in loop with personnel managing the workplace**.**

2. PROPOSED SYSTEM

- **Artificial intelligence**

  Through this technology dyeing machines and equipment learn, decide and work intelligently while negotiating a coloration process. For instance a dyeing recipe formulation and fixing dyeing condition consistent with the shades and sort of dyes. Classification in AI expert system, Artificial Neural Networks (ANN), symbolic logic, Generic algorithms and tongue. AI- system are one among the choices available n the textile industry to

integrate the weather like production, quality, cost information, statistical process control, just in time manufacturing, computer integrated manufacturing, expert systems and artificial neural networks are introduced and future potential for the Indian textile Industry assessed. ANN- fabric colour fastness grading, fabric inspection, scheduling of dyeing process, novel optimization and deciding algorithms (AI). It can implement any task that a person's sensory system can do. Colour fastness test samples are compared with standards for grading. ANN are often wont to map the connection between human grading and a picture of tested samples facilitates the dye recipe selection. ANN applications are mostly utilized in five categories viz. prediction, classification, data association, data conceptualization and data filtrating.

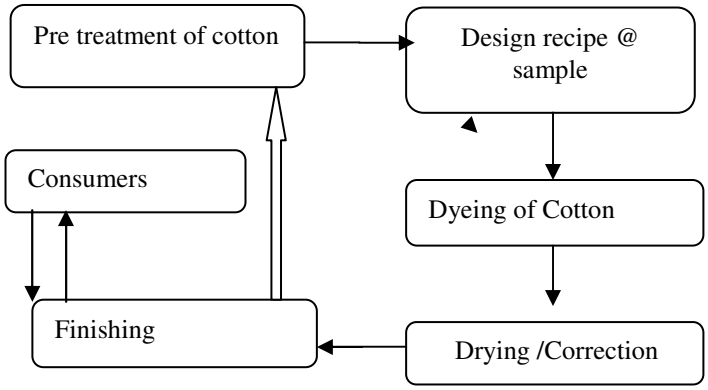

Fig. 1. Application process of Artificial intelligence in Dyeing industry

- **Expert systems:**

  Expert systems are used for execution and advisor role which exhibit intelligent behavior, learn demonstrate, explain and advice its users. The dyeing machines in this smart dyeing plant will able to implement human intelligence in machines. This application will integrate machine, software and special information to provide explanation and advice to end user.

- **Vision systems**

  Understand the visual inputs related to samples and products on computers. The expert system able technology to diagnose and identify the faults in the shades or in fabric.

- **Intelligent Robots**

  Equipped with multiple sensors, efficient processors and huge memory to exhibit the work execution. I.R can be an effective alternate for working in non-human conditions viz. excessive temperature, humid and hardship zones.

- **Machine learning**

  Intelligent dyeing and textile processing machines are taught through data input, text files, SQL, data bases, data abstraction using algorithms and generalization. The longer term smart dyeing machines enabled with ML, move through the info to seek out the patterns and when found, adjust the program's actions accordingly with the assistance of pattern recognition and computational learning theory, one can develop algorithms. ML may be a sort of algorithm that permits software applications to become more accurate in predicting outcomes without being explicitly programmed input file and to predict output.

- **Block chain**

  The information is packaged into blocks which link to form a chain with other blocks of similar information. This linking blocks into a chain that makes the information on a block chain trust worthy as once the data is recorded in a block cannot be altered without having a change every block that come after it.

- **5 G Fifth generation**

  It is wireless communication with very high quality streaming and downloads. Because communication between machine and human is instantaneous programs and controlled results are a reality. RelianceJio in India has provided this facility in India, otherwise it is available in developed countries.

- **Colour matching**

  Establishment of tolerances with the help of quantifiable tolerance. Traditional computer colour

matching system is based on numeric descriptions of colours through instrumental tolerance systems. AI can develop pass/fail system to improve more accuracy due to human intervention interfaces.

3. CHALLENGES AND OPPORTUNITIES

The major challenge is the textile dyeing industry is labor oriented and highly quality conscious. At the same time shortage problems of skilled labour and experts can be neutralize by adoption Smart and automated dyeing plant.

4. CONCLUSION

Dyeing is often complex and even cumbersome. Dyeing quality and performance are directly controlled by time, temperature, pH, and chemical auxiliaries. Dyes are fiber specific and have their individual advantages and drawbacks they need to be processed under careful control. The goal of dyeing is to supply the very best quality on-shade product which meets all of the customer's specification for colorfastness and color durability. This dyed product should be produced within the shortest amount of your time, using the smallest amount of energy, generating minimum water waste. This produces the foremost profit for the manufacturer and therefore the highest quality product for the customer. Businesses looking to leverage AI to reinforce quality, production and lower costs would require an outsized trove of existing data for AI applications to find out from and significant amount of your time, costs and domain expertise for successful integration. Adoption of green technologies including enzymatic dyeing is also possible through this technology.

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Weft Knitting - An Innovation for Technical Textiles

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ABSTRACT

Weft knitted products have a flexibility that offers many attractive possibilities. Knitting Functional aspects as breathability, stretch, seamless feeling have to be combined with trend setting designs in the global markets. The opportunities can be applied to various types of sports and its functional and aesthetics. The weft knitting techniques allows partial stretch, compression and shaping in the product & realizes high comfort zones. It helps to create innovative designs opportunities for the leisure style. Weft knitted fabrics designed for various shapes and frames. Partial control of the fabric's stability by inlayed threads. In this research paper, it has been shown the possibilities on reshape the future with zero wastes. Textiles are present in 100% of Our Daily Lives providing a continuous connection between the human body and the digital world. The conceptual emphasis into the trends of technological advances and proposes possible pathways to optimize use of the Computerised Flat Knitting machines. Virtual knitting procedures created on CAD & would be presented in virtual reality and experience the online showroom that can be operated without the need for producing or displaying actual samples. The CAD system performs realistic simulation of yarn, pattern and design structures etc. Patterns are created automatically based on measurements. Computerised Flat Knitting challenges of tomorrow's market & enhances the entire value chain efficiency. Weft knitting technology creates new solutions with selective cushioning and elasticity to fit the human shape and find cutting - edge solutions to improve performance & Comfortable support and protection applications have to assist the natural body movements. The whole garment knitting technology reduces the manufacturing process like body and sleeve joining and zero materials waste. It is more capable of yarn into complete seamless garments with in just a minutes with minimum yarn cut and sewing techniques.

Keywords: Weft Knitting, Integral Techniques, Product Development, Seamless Knitting, Technical Textiles

1. INTRODUCTION

Technical knitted-fabrics have gained steadily in importance becoming a substantial growth market. The economic purview and importance of technical textiles encompasses not only the textile industry but has extended its impact on just about every sphere of human economic and social activity. Technical textiles represent the fastest growing sector in the textile maybe because there is no market segmentation as it caters to many sectors be it upholstery, automobile, medical, geo-textile, agro-textile to name a few. The uniqueness and challenge of technical textiles lies in the need to understand and apply the principles of textile science and technology to provide solutions defined by the application area. Hence, this uniqueness leads to innovation that helps building a better world. Due to its flexibility, stretch and distortion, knitted fabrics are now in more demand than woven and nonwoven fabrics. Hence development of knitting techniques and machines are still focused in technical textile industry.

The technology is applied to home fashion, body wear, outerwear, swimwear, performance wear and sportswear. Knitted directly from yarns to a single garment. Nowadays, consumers focuses on value size-fit, value aided knits structures and prefer clothing customized to their body figures. Seamless / whole garment knitting is an advanced knitting technology that has the capability of making ready to wear garment directly from the yarns without any side seams. "There are more possibilities in the design and structure of garments with better size fit and comforts" (Gross, 2001). A variety of different knits stitches can be created within a single garment by using a combination of the constituent materials and needle pattern selection. In order to this, a lot of developments and excellence have been added in the technology and software of flat-bed machinery for weft knitting since the late 1980s. Many new knitting technologies at ITMA centered on energy efficiency and waste reduction, and shoe uppers offer an interesting new market for knitters. Technical features driving innovation include spacer fabrics, weft insertion, air splicing and inverse plating.

Inverse plating technique offers designs of special single-jersey jacquard, which used to be knitted by special high-value intarsia machines. The Spacer fabrics commonly known as two-faced fabrics are knits comprised of two main layers connected by yarns transformed in tuck, knit & miss associated by separate fabrics as connecting layers. Performance wear, outerwear, swimwear, lingerie and shape wear are widely produced through this Seamless technology.

Weft knitting technique produces fabric directly from fibres with innovative material structures combining air jet spinning and knitting into one process. Knitting machine operator may able to change the yarn count during the knitting process that leads to save a lot of development time. It offers fabric of same volume using less amount of raw material and more customized products. The shaping techniques is becoming more interesting with the fast progressing development of V - bed knitting machines. This techniques makes it possible to three dimensional technical textiles. Fibres are composed of new materials that have not been used in the textile industry before, such as thin metal threads, glass fiber and optical fibres. The techniques with a three dimensional (3D) mesh structure, designed to keep the wearer feeling cool, dry and comfortable. The nylone/ lycra elastane blend fabric with water repellent properties; facilitates excellent air flow and moisture management. The textiles receive new functions and new use areas of technical textile. Change is the process by which the future invades our lives. "The innovative approach of product development have greatly influenced in modern technology. Its involved the fastest technological improvement in knitting product "(Matkovie, 2010). Continuous process of creative and innovative ideas proposed five assumptions in process of innovation in design development occur in a knitwear industry. Advancement of knitting technologies emphasis in "the performance wear of athletes, it ensure the vital accuracy construction and produces minimum waste by eliminating additional materials" (Wilson, A, 2012). Using of "Partials & Integral techniques knitting are great success of future innovation and applications" (Ralph, I., 2015).

The compression garments can be individualized by weft knitting technology. The requirements according to the control of compression values can be met. The creation of seamless garments and the exact measurement of individual pieces corresponds to the expanding requirements of individual customer care. Compression wear, compression hosiery are examples for seamless knitwear for lymph diseases, venous weakness or hypertrophic wounds. The usage of the ability of elastic threads is used as a base for applications in healthcare in general, orthopedics, wound care and prevention of physical injuries. Bandages have to meet several requirements. A flexible structure shaped individually by providing a maximum of mobility is the focus. They activate the system, stimulate blood circulation by compressive knitting structures and supports curing diseases and injuries. The integration of specific structures as tubes and eyelets make it possible to integrate stabilizers.

The fabric is made from nylon and elastane yarns, and the nylon yarns incorporates a large number of filaments - which makes them extremely durable. The fabric designed to be strong, lightweight and flexible, and it boasts a number of performance properties including: (a) moisture wicking properties; (b) antimicrobial properties; (c) anti - odour properties; (d) an ultraviolet protection factor $(UPF)^2$. The equipment used for testing compression garments. (a) climate control chamber; (b) thermal sweating manikin; (c) pressure testing apparatus (d) tensile strength tester. Athletes have experimented for years with compression garments in sports both as an ergogenic, performance enhancement and recovery aid. The majority of commercial branded garments currently available for sport applications are claimed to provide the wearer with enhanced blood flow, better muscle oxygenation, reduced fatigue, faster recovery, reduced muscle oscillation and reduced muscle injury.

2. METHODS AND MATERIALS

The method used is literature survey and experimental work on weft knitting CAD / CAM.

Source: Stoll & Shima Seiki

The weft knitting CAD / CAM features: (a) Multiple-variety, small-lot production; (b) Quick response (c) Design based on each customer's technology; (d) Support of a variety of materials; (e) Sustainable production using minimum material; (f) Three-dimensional shaping; (g) Optimum construction and compression.

Latest advancement in the computerised knitting is the Digital Stitch Device, with which desired loop length can be achieved, which enables the user to control yarn consumption and adjust tension of yarn and digital take down mechanism. This not only enables consistency in the design but also enhances the overall look and feel of the product. The weft knitting's challenges and opportunities are taken into consideration and implemented in the development of innovative product. Weft knitting technology generates knit-to-shape products, allowing flat fabric sections combined with tubular zones and curved.

3. RESULT AND DISCUSSION

The CAD / CAM improves on the design evaluation process with its ultra realistic simulation capability. In continuous, system realizes significant savings in time, cost and material, its contributing to Zero waste manufacturing. After much discussion over the need of development and enhancement in the flat knitting technology, it has been seen that industry professionals as well as students who may enter this industry are continuously brain storming to achieve these progressions in the weft knitting. One can say that with so many excellent and highly knowledgeable minds at work for this cause, the future of Knitwear is bright. These developments in fields like 3D knitting and others will not only benefit the fashion industry but also the medical textile industry, automobile textile industry, shoes making industry, etc. Developments may also benefit the country’s armed forces. There is much to look forward to in this field in the coming years. The vision 2030 would be based on Artificial intelligence. The main task has been to knit the Shape and structure for the product. Wearable electronics present exciting possibilities using 3D structure.

It may be pointed out that the impact of synthetic fibres on Indian knitting industry is significant. Technological revolution is never ending. It is a continuous cycle. When one revolution appears to be ending, another has already begun. This is all the more true of synthetic fibres and knitting industry. Whenever newer and newer types of raw materials are made available to the knitting industry in India, they have always come out with new and significant development of the benefit of consumers & product development may be made by choosing the right quality yarn, knitted on a correct knitting machine which are running at optimum efficiency. Proper fabric selection and right processing is the key to trouble free knitwear production. Special ability and versatility offered by weft knitting technique is having vast applications.

It is suggested that weft knitting offers most scope of future expansions. In order to promote compliance in rehabilitation, traditional barriers that have existed between design and technology must be removed. As well as knowledge of technical textiles and sophisticated garment manufacturing techniques, such as moulding, bonding and welding, knitwear designer / product developer need an awareness of the technology of wearable computing.

4. CONCLUSION

The Weft Knitting Technology available to the Fashion Industry right now can only provide so much to us. But due to the constant developments in technology, it is certain that numerous changes will be seen in the coming years. In about last two decades many visions in the field of flat knitting can be put into practicality. Consider the invention of an Artificial Intelligence that could provide us with numerous options of structure, designs, panels, etc. on the basis of your preferences and choices. It could give you the exact structure and paneling that needs to be knit for the perfect desired fit. Customization of garments in this field could achieve new heights. Maybe, one could even order their choice of customized product on an online portal or website that provides with innumerable options. New structures might also be developed in the coming years. New yarns and fibers can be developed that will further widen the options in knitting. Communication tools for knitwear designs and structures can also be further developed. Perhaps, we might even be able to develop a soft-ware much similar to Google docs but for sharing and editing knitwear designs across seas and borders, be multiple innovative minds.

Advancement in technology will be beneficial for all in this industry and will provide with new paths to be further discovered. New advancements coming from

fiber producers and yarn spinners will continue to provide innovative materials. There is a need for amore creativity and differentiation in seamless knitting structures and finishing, which will make them even more unique, functional, and popular. Performance garments for sports activities and those in the fitness and wellness market are potential growing markets.

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Innovation in Fashion and Textiles

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ABSTRACT

Innovation takes place at the intersection of fashion and technologies, representing a powerful way. To connect consumers to brands while providing distinct shopping and wearing experiences. New Technologies and textile innovations are not only changing how the fashion industry functions, but also how its products interact with the environment and consumers. The fashion and textiles Discipline is highly diverse, covering natural sciences, humanities, social sciences, and the arts. In today's rapidly changing, increasingly complex environment of academia and industries, this Discipline is becoming ever more intertwined. Fashion and Textiles provides scholars and Industry experts a platform to showcase the latest progress in this exciting and ever-developing Field. It might sound futuristic, but fashion tech is actually already conquering the world of Fashion, retail and innovation.

Keywords: Intersection, discipline, innovation futuristic, intertwined.

1. INTRODUCTION

Fashion refers to anything that becomes a rage among the masses. Fashion is a popular aesthetic expression. Most Noteworthy, it is something that is in vogue. Fashion appears in clothing, footwear, accessories, makeup, hairstyles, lifestyle, and body proportions. Furthermore, Fashion is an industry-supported expression. In the contemporary world, people take fashion very seriously. Fashion is something that has permeated every aspect of human culture.

Fashion Tech is becoming a rapidly growing and vibrant ecosystem that is now supported by incubators and accelerators whose focus is to guide new Fashion Tech innovators. With technology can create a more robust, energetic, transparent and sustainable fashion ecosystem instead of an energy-depleting fashion market treadmill with uncertainty, miscommunication, misalignment and misdirection.

Automation, robotics and RFID: The use of RFID – the technology for reading and transferring data – is also a very promising field, especially when applied to all stages, from manufacturing to the point of sale. Emerging textile technology and innovation companies are developing interesting solutions to optimize retail processes and create insights into customer behavior by "digitizing" garment production.

2. LATEST INNOVATIONS IN TEXTILES

- **Elastic Textile Display**: A new ultrathin elastic display that fits snugly on the skin can show the moving waveform of an electrocardiogram recorded by a breathable, on-skin electrode sensor. Combined with a wireless communication module, this integrated biomedical sensor system, called "skin electronics," can transmit biometric data to the cloud.

- **Bacterial Textile Dyes**: The fashion industry is the second largest polluter in the world. To counter the ecological disaster, a startup with the help of bacteria has developed an alternative to chemical textile dyes and conventional plant dyes!

Bacterial textile dye

- **Solar Power Fashion**: Luxe solar-powered fashion that uses miniature photovoltaic cells as a design element rather than something to be camouflaged. Diffus for example wired 100 tiny solar panels onto the bag's exterior—enough to generate juice to power the cellphone or other mobile device.

Illuminated hand embroidery

- **Illuminated embroidery**: Clara Daguins models are changing in contact with technology. Integrated filaments, circuits and sensors make their clothes glowing "Body Electric". Offline is no longer an option.

- **Virtual Fashion**: We could use the virtual worlds to free ourselves from norms, bring out our personality, and use algorithms to calculate fashion trends. The Dutch fashion designer Jacob Kok shows how it's done.

- **Textile Hacker**: The stuff of the future is created by Data Paulette through sharing and open source. A handful of passionate engineers and designers provide a platform for everything that brings together the interplay of fashion and high tech, fabrics against electro smog, as a source of light and sound or "textile".

- **3D Printed Fashion**: When the designer trio of New York's fashion label, three ASFOUR, pampers the 3-D printer, a fabric comes out that adapts to the body and its movements like a snakeskin. The templates are from sacred geometry and wildlife. Three ASFOUR conduct high-tech research with the aim of creating harmony between man and nature.

3D Printed fashion

- **Interactive Fashion**: Chinese-Canadian designer Ying Gao designs interactive dresses that watch us, communicate with us or silence us. Fashion that makes itself independent and questions how we treat each other.

- **All-rounder Sneaker**: Nancy Karim Oumnia creates an all-rounder sneaker that counts our steps, binds itself and has a temperature controller. In the future the sneaker will also replace the doctor, because the built-in sensors collect data which helps diagnose diseases.

3. CHANGING THE FASHION WORLD

Algiknit: It produces textile fibers extruded from kelp, a variety of seaweed. The extrusion process turns the biopolymer mixture into kelp-based thread that can be knitted or 3D printed to minimize waste. The final knitwear is biodegradable and can be dyed with natural pigments in a closed loop cycle.

Algiknit

BioGlitz: This company produces the world's first biodegradable glitter. Based on a unique biodegradable formula made from eucalyptus tree extract, the eco-glitter is fully biodegradable, compostable and allows for

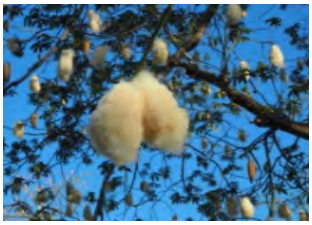
the sustainable consumption of glitter without the environmental damage associated with micro plastics.

Bio Glitz

Circular fashion: It has created software that interconnects circular design, circular retail models and closed loop recycling technologies enables fashion brands to design circular garments. Circular clothes are attributed an identification tag that orchestrates a reverse supply chain network of consumers, sorting and recycling companies to close the loop to regenerated textiles.

Circular Fashion

Flocus: The Company produces natural yarns, fillings and fabrics made from kapok fibers. The kapok tree can be naturally grown without the use of pesticides and insecticide in arid soil not suitable for agricultural farming, offering a sustainable alternative to high water consumption natural fiber crops such as cotton.

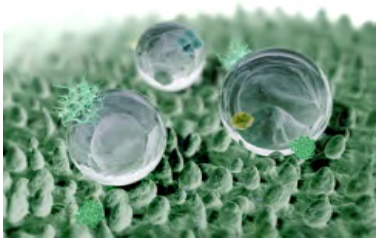


Flocus

Frumat: The brand uses apples to create a leather-like material. Apple pectin is an industrial waste product which can be used to create sustainable materials that are totally compostable whilst still being durable enough to create luxury accessories. The leathers can be dyed naturally and tanned without chemically intensive techniques

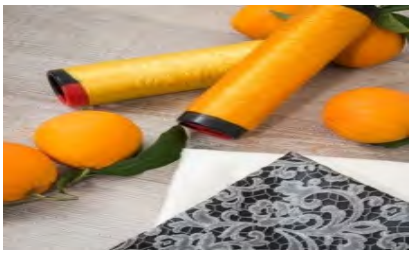
Mango Materials: The company produces biodegradable bio-polyester that can be used as a sustainable alternative to the present polyester utilized in the fashion industry. Microfibers produced from the biopolyester can biodegraded in many environments, including landfills, wastewater treatment plants, and the oceans helping to prevent microfiber pollution and contributing to a closed-loop bio economy for the fashion industry.

Nano Textile: It offers a sustainable alternative to binder chemicals normally used to attach finishes onto a fabric. Its technology embeds fabric finishes directly into fabric using a process called Cavitation and can apply to a range of products such as antibacterial & antiodor finishes or water repellency. This protects the end-user and the environment from the leaking of hazardous chemicals.



Nano Textile

Orange Fiber: This Italian company manufactures natural fabrics from citrus by-products. Orange Fiber is made by extracting the cellulose from the fibres that are discarded from the industrial pressing and processing of oranges. The fiber, through nanotechnology techniques, is enriched with citrus fruit essential oils, creating a unique and sustainable fabric.



Orange fiber

4. ADVANTAGES

The textile industry is varied, which means that many countries choose their own path and direction to follow, whether that is medical textiles or high fashion. However, there are a few trends that seem to be the new direction for most of the textile market.

- **Technology** - Technical textiles are a large and growing market right now. Countries are rehabilitating mills and buildings and hiring new staff to work on new innovations like 3D printed clothing and shoes or smart fabrics with small chips that act as conductors and energy converters.

- **Non-Woven Fabrics** - New machinery has made it possible to pursue non-woven fabrics. Non-woven's are non-yarn materials that are pressed together rather than woven. The reason this is an advantage is the labor is less intensive and the product can be made quicker and for less money. Non-woven fabrics are also very hygienic, which is great for the medical field, a large part of the textile industry.

- **Environmental Sustainability** - The environment has become a large issue in the textile industry due to the immense use of water, the air pollution and waste concerns. Many countries have started to really focus on **green textiles**. Some of the new innovations are making clothing out of used coffee grounds, algae, or spoiled milk. These new textiles are unique and are gaining popularity in the market.

5. CONCLUSION

The house of innovation, a model which is a transpose of the house of quality which can be used to measure the innovation gap in the fashion industry by listing down the identified context parameters in both the axis of the matrix and evaluating the interrelationships between them and correlation within them. Ultimately, whether or not digitization causes a change in garment production (e.g., increasing near shore production) depends on many more factors than just technological feasibility. But technological limitations must be overcome, especially in interface issues such as accessing data from older textile machine .The fashion industry has been heavily influenced through inventions and innovation. Because trends are fluid and ever-changing, clothing retailers can hop on board with the latest in tech innovations to appeal to their customer base and stand out among the competition. In general, the greatest advantages of new technologies are that they make production more efficient and faster, offer higher quality, enable more personalized products and create new business models.

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Study on Foot Ergonomics for Athletic Shoe

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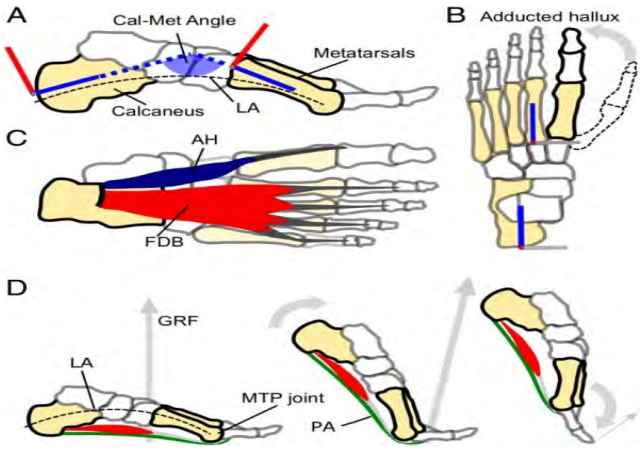
Ever since people got aware of sports, sportspersons have used athletic shoes to not only enhance performance but safeguard their feet. As sports have evolved, so have the features of athletic shoes. The study of physical ergonomics is concerned with human anatomic, anthropometric, physiological, and biomechanical characteristics as they relate to physical work systems.

The function of the athletic shoe is to guard the feet while aiding sport performance. The four components of an athletic shoe are the outsole, midsole, upper and the insert which provides support, stabilization and protection to foot. Athletic footwear plays an important role in preventing injuries at the playground, such as compressions, impacts, punctures, as well as slipping. To fulfil this role, athletic shoes must not only meet basic requirements including toe-protection and slip resistance, but also penetration resistance, good wicking, flexibility and isolation, depending on the area of application. Wearing the proper athletic shoe for particular sports and also for specific foot types can help in all the three parameters of athletic shoes-Comfort, Performance and protection. Athletic shoes are made for sport-specific to deliver extra features that are significant to the sport played. Certain examples of this are added cushioning for running shoes, and added traction for tennis shoes.

Ergonomics is a science behind creating product more consumers friendly. Each pair of feet varies in form, shape, and size. There are three different foot types: neutral arch, low arch, and high arch. The height of the arch affects the direction and severity of the way foot rolls – or pronates. Three-dimensional (3D) information about static and dynamic foot deformation during standing and walking seems to be of great importance for proper footwear fit (D'Aout et al., 2009; Kimura, Mochimaru, & Kanade, 2008; Krauss, Valiant, Horstmann, & Grau, 2010; Morio, Lake, Gueguen, Rao, & Baly, 2009). There is no doubt that the foot changes its shape under different loading situations during standing and walking (Coudert, et al., 2006; Kouchi et al., 2009; Leardini et al., 2007). Researchers analyzed the movement of foot bones during walking and slow running and found that all examined joints moved and that these movements were higher than expected in some joints (Lundgren et al., 2008; Nester et al., 2007). Changes in different static loading situations, such as foot length, width of rear foot and forefoot, and height of arch and instep, were reported with regard to foot shape (Tsung, Zhang, Mak, & Wong, 2004; Xiong, Goonetilleke, Zhao, Li, & Witana, 2009).

Athletic shoes design based on ergonomics should emphasis on two characteristics: First, to meet the requirements of motor function; the second is to reduce physical exertion of the athletes so as to support and protect bones and tendons. Ergonomics has also improved the way we wear shoes. Every move of an athlete transfers about 2.5 times their body weight into the ground and this force is absorbed through the shoe so that it does not have as much of an impact on your legs, hips, shoulders and the rest of the body. Ill-fit footwear put extra strain on the feet and thus accentuating pain in the entire body. This can result into injury, linked physical problems, and even mental stress. Therefore foot type should be assessed when determining an individual's risk for metatarsal stress fractures. (The effect of foot type on in-shoe plantar pressure during walking and running)
(Herbaut, August 2015)

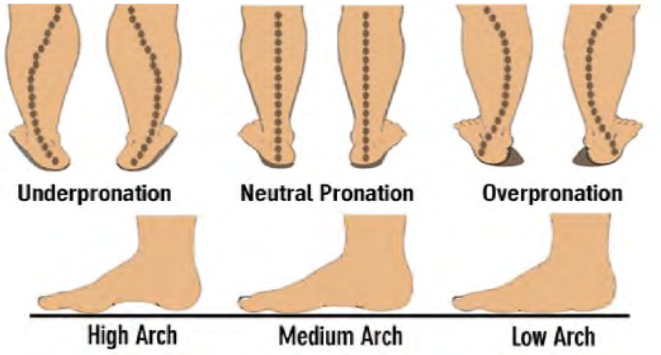


(Herbaut, August 2015)

(Pang)

Foot strike-which part of the foot strike first to the ground

This clearly states studying foot ergonomics is very essential while designing any Athletic shoes. In Heel striking collision of the heel with the ground produces a substantial impact transient, almost immediate large force, which in return affects the performance of the athletic shoes and amateur athletes. Pronation mentions to how the body allocates weight as it sets through the gait. There are different types of pronation which do affects performance and comfort of athletic shoes. Footprints with a very narrow, curved shape are said to represent high arches and thus under pronated foot types. Over 90% of people have different sized feet.(http://www.footpainreliefstore.com/library/shoelast.htm) There are different kinds of Arches found in human feet. Normal Arches Keep your arches in great shape with shoes that have firm, thick soles, good cushioning, and keep your heel stabilized .Flat Feet require shoes that keep your foot from rolling inward, or pronating excessively. Shoes with a thick- cushioned sole and lacing that allows you to restrict movement in the shoe add support for the flattened plantar fascia with Heel Seats. High Arches Shoes with cushioning are extra important in the case of high arches. These shoes are typically heavier on cushioning and less rigid as it requires slip in high arch supports to add targeted cushioning and acupressure to help feet absorb impact properly.



(Pang)

Effects of Footwear on Metatarsophalangeal Joint

Figure 2. Locations of the reflective balls on the feet. (a) Inside view; (b) lateral view; (c) posterior view.

J. Med. Biol. Eng., vol. 29. No. 4 2009

6. FUNCTIONAL FOOT GROUPS

There are 6 functional foot groups (called "Quads"), which affects gait style, injuries and performance of both athlete and athletic shoes. Over time, no matter what type of footwear you are wearing, how you walk will be demonstrated by the wear on the bottom or outsole of the

footwear. The style of walking depicts gait and during the walk the foot shape decides how your foot rolls, leading to need of special kid of orthotics and inserts so that the athletic shoe which the athlete is wearing is stable and comfortable.

(Note, April 18, 2019)

https://www.theunionbootpro.com/

To study foot ergonomics Stratified Random sampling of foot of amateur athletes of varying age group from Delhi NCR were taken for preliminary work and "**Wet Foot Test**" was performed to find their foot ergonomics.

Boys foot prints

Girls foot prints

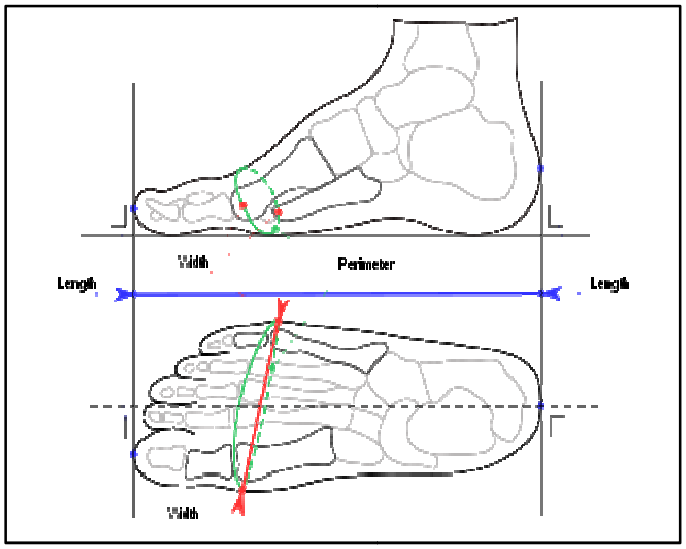
After examining 27 random samples of amateur athletes following conclusions were made as per their foot shape:

FOOT SHAPE	TOTAL NUMBER OF FEETS
Normal Arches:	11
Flat Feet or low Arches:	4
High Arches:	12

Amateur athletes between varying ages of 13 – 16yrs. of age have following foot size

UK/India (Foot size)	EU (Foot size)	USA (Foot size)	LENGTH (mm)
3.5	36	6	225
4	36.5	6.5	230
4.5	37	7	235
5	38	7.5	240
5.5	38.5	8	245
6	39	8.5	250

Eight Amateur athletes (four males and 4 females) with normal foot arch and without foot deformity were examined. Arch index was calculated from a footprint.



7. TO MEASURE YOUR FOOT SIZE

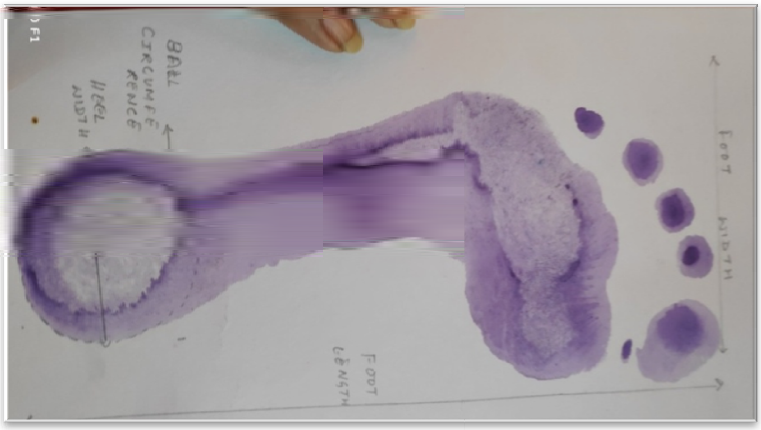
Step 1: Measure length of foot

Step 2: Measure Width and Instep

Foot Length

Foot Width

Foot Circumference

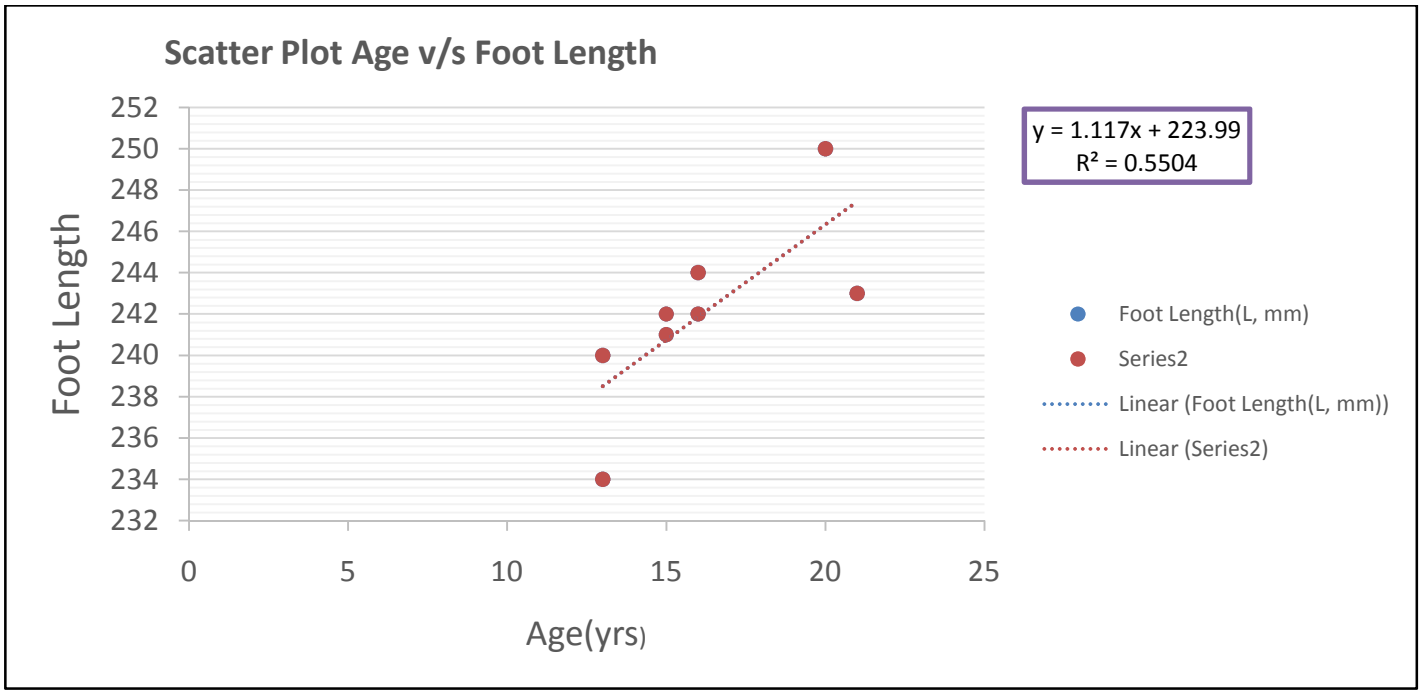


Pictorial description

Characteristics	Subject									
	1	2	3	4	5	6	7	8	Mean	SD
Gender	M	M	M	M	F	F	F	F		
Age	15	16	13	16	15	16	13	16	16	2.75
Height(Cm)	163	162	160	165	162	164	163	164	163	1.4
Weight(Kg)	53	56	50	58	48	50	48	54	52	3.4
Foot Length(mm)	RL	RL	RL	RL	RL	RL	RL	RL	243	4.1
	241 242	242 243	234 236	250 251	242 243	244 245	240 242	243 244		
Foot Width(mm)	97	96	86	98	86	84	84	87	89	5.7
Heel Width(mm)	65	66	59	71	64	58	57	64	63	4.7
Ball Circumference(mm)	231	230	218	231	220	221	219	232	225	6.2
Instep Circumference(mm)	220	222	219	234	220	221	218	231	223	5.9
Span Circumference(mm)	300	296	294	310	292	293	290	301	297	6.4

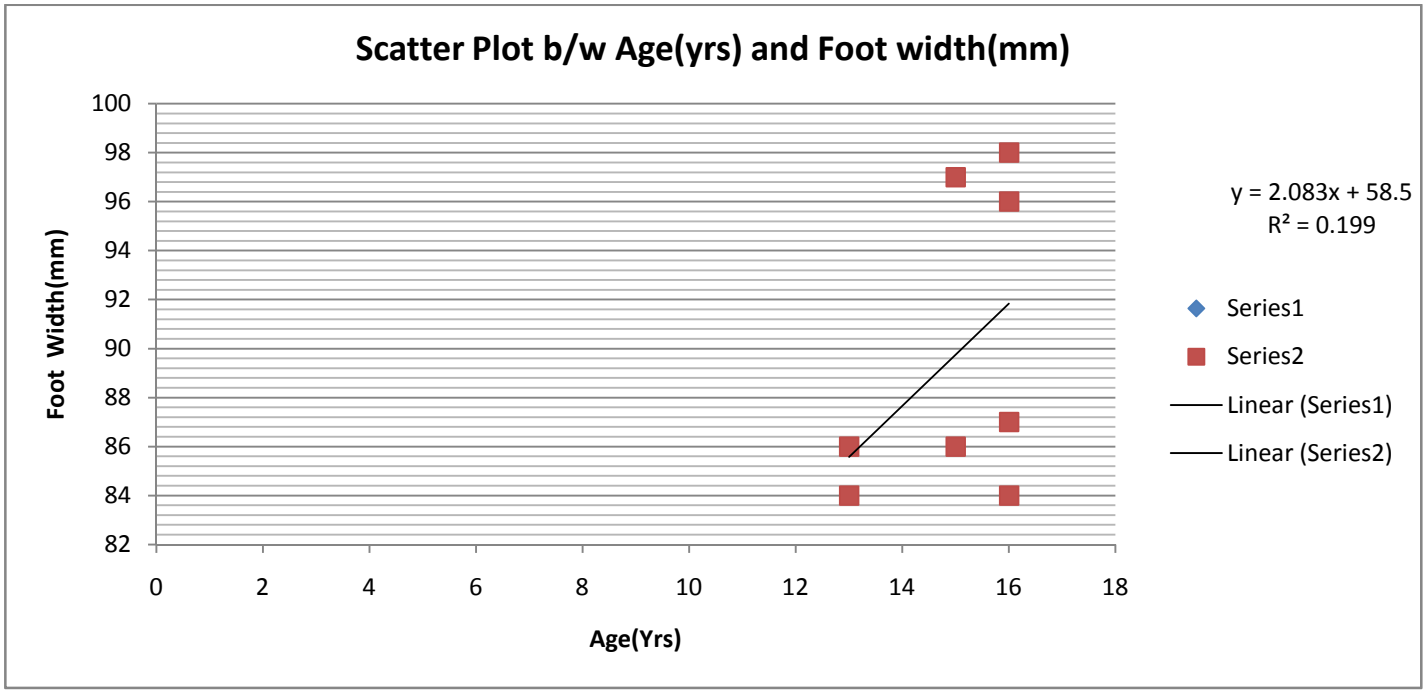
SD = standard deviation, L = left foot, R = right foot

Note: Foot shape data were measured with sliding caliper and cloth type in non-weight-bearing sitting posture.



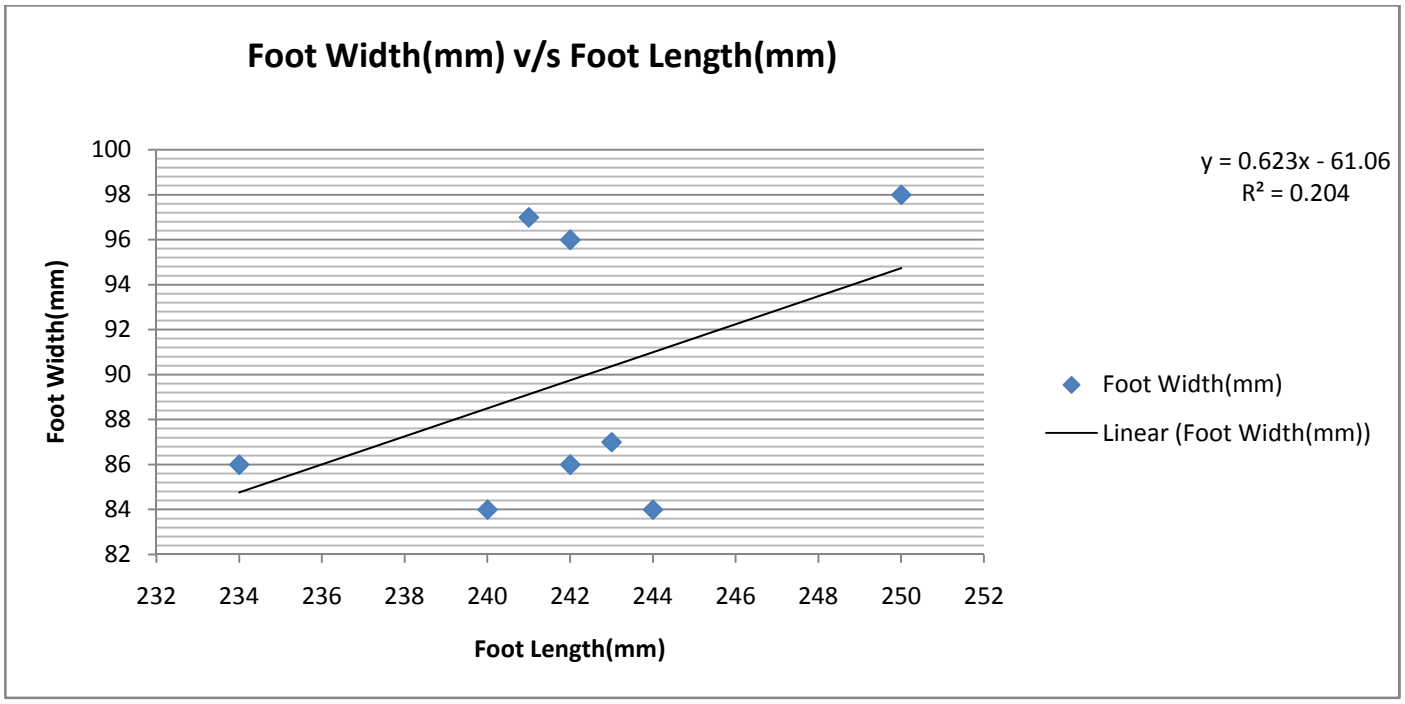
Inference

The Age / Foot Length relationship accounts for 55% of variations. There is positive linear relationship between Age and Foot Length.



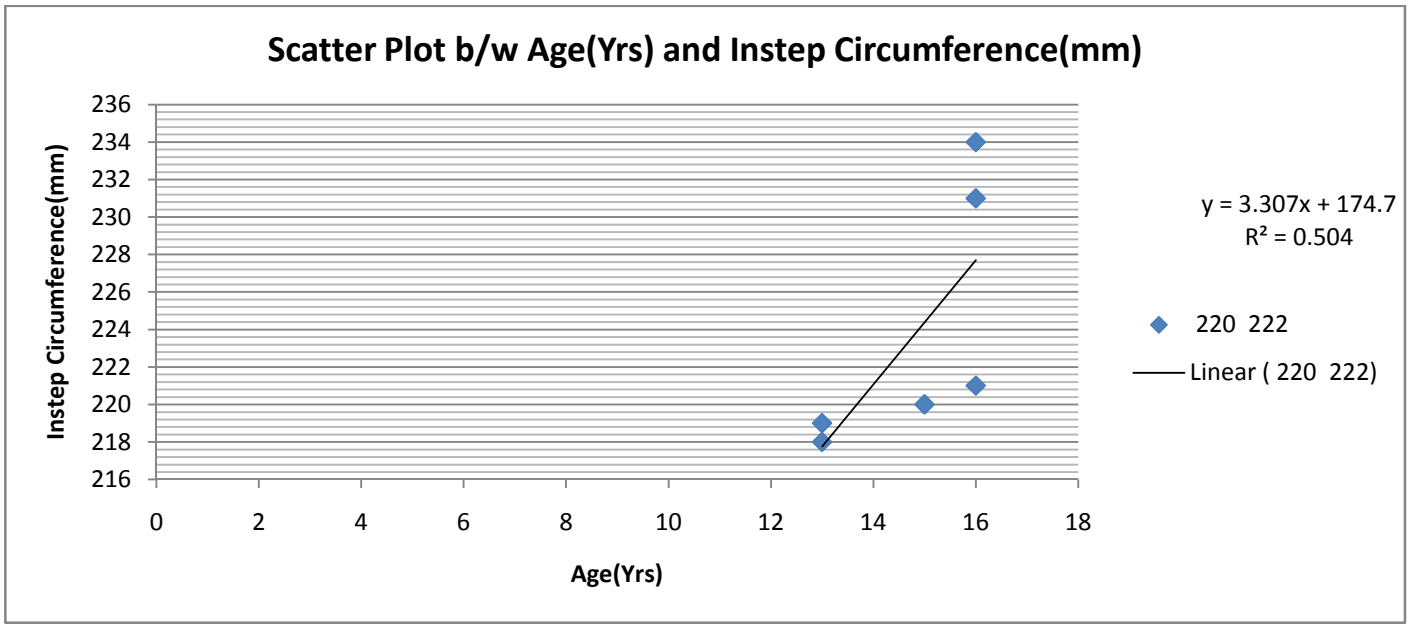
Inference

The Age / Foot Width relationship accounts for 19% of variations which indicates a weak correlation between the variables Age and Foot Length.



Inference

The Foot width and Foot length relationship accounts for 20% indicates a weak correlation between the variables.



Inference

The Age / Foot Length relationship accounts for 55% of variations. There is positive linear relationship between Age and Instep Circumference.

Apart from the described gender differences, none age-related differences of foot between Girls and Boys were seen in amateur Athletes but however there is positive linear relationship between Age and Instep Circumference of foot and Age / Foot Length. So while

designing any athletic shoe these two variables should be considered.

8. CONCLUSION

Feet take a tremendous amount of pressure throughout the day, particularly for people who work in professions that require standing or walking for most of the day. Ill-fitting shoes can worsen the issue of toe pain: Choosing the right shoes as per your feet shape and arch height has a much greater impact on health. To find the best running shoe one has to be aware of one's foot type and what type of shoe best supports their arch and running style. The right shoe may prevent injury and promote performance. Customized shoes and virtual 3D tailoring has become need as today's customers' along with aesthetic beauty look for better comfort and fit. With the need of better fit along with length and width of shoes there is need for development of new techniques for fit quantification so that direct mapping from foot to shoe-last can be achieved. Computer-aided design (CAD) and computer-aided manufacturing (CAM) is sure to have a bright future in reading and developing Athletic shoe as per individual foot shapes.

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[14] file:///D:/amity%20Ph.D/5b8f50ecd487203058fb06fcea1af8b0e2f7.pdfClassification of Synthetic

[15] TensilePropertiesofIndigenousKenyanBoranPickledandTannedBovineHide

[16] Polyurethane Leather by Mechanical Properties according to Consumers' Preference for Fashion Items

[17] Eui Kyung Roh, Kyung Wha Oh1*, and Seong Hun Kim2

ABSTRACTS
OF POSTERS PRESENTATION

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Ghisa: A Sustainable Solution to the use of Synthetic Yarns

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The paper presents exploratory research on the production of three primitive varieties of silks in Assam. *Muga* silk and *Eri* silk are non-mulberry silks whereas *pat* silks are mulberry silks which dominates the handloom industries in Assam. Another variety which comes into existence is *Ghisa* that is extracted from *muga* wastage. Typically, *ghisa muga* is obtained when the filaments break or the outermost and innermost portion of the *muga* cocoon yields silk noils (very short fibres). This uneven waste yarn of *muga* has an important aspect of having most of its qualities but at cheaper rates.

The increasing use of synthetic materials for the yarns is discouraged as it has been in constant factor contributing to the worldwide plastic pollution. In this field research, an attempt was made to utilise Ghisa into designing which is conventionally treated as wastage till now or rarely utilised for the production of plain woven fabrics. Ghisa silk was used for creating motifs which were developed on traditional jacquard loom based on a theme. To bring in the indigenous essence, the designs were inspired from Assamese culture which was further used for a contemporary range of products. The natural colour of Ghisa silk was kept intact to render an indigenous visual appeal to the fabric.

Keywords: Muga silk, Ghisa silk, Assam, Weaving, Sustainability.

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Conservation of Textiles: A Sustainable Approach

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The current global scenario has now more than ever shed a light on and brought to the surface the importance of sustainability in various fields of fashion and textiles. While the use of sustainable methods is given an importance for current fashion needs, it becomes important to incorporate the aspect of sustainability to textile conservation as well. What is considered current fashion now, will eventually become a part of our history and legacy in the future. Thus it becomes imperative to have a plan in place to conserve these textiles when required.

Textile Conservation is a process whereby with the use of preventive and curative treatments, a textile is cared for so as to prolong its life. It has been practiced for years, and while ethics of conservation has been given importance, the materials and methods used have not always been the most safe and environment friendly options, and thus present a risk to the conservator as well as the environment.

The poster will focus on elaborating on incorporation of sustainable methods at various levels of preventive and curative conservation methods. This includes how to develop a sustainable lab, selection of efficient equipments without compromising the guidelines of conservation, usage of 'green' and 'greener' solvents, chemicals, support materials, adhesives and methods of conservation, with a comparison between innovative and traditional methods, and green practices in collection care which will be evaluated on the basis of sustainability of energy consumptions, passive systems and microclimates. The aim is to incorporate a sustainable approach in the various facets of textile conservation, ensuring that while we work towards prolonging the life of our history, we do not compromise with the resources of the present.

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A Study on Consumer's Attitude towards Sustainable Fashion

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The depletion in the natural sources is exponentially increasing and there will be nothing left in the years to come, so there is an urgent need of sustainability in all the aspects and specially in the clothing sector as it is the basic amenity and 2nd largest polluting sector.

The research was carried out in estimation on what scale people are considering sustainable fashion over their regular fashion. How many of them are concerned about the sustainability factors, how many of them are thinking about the generations to come and above all how many of them actually know what sustainability is.
Questionnaire was used as a tool for research. Hence, the paper has briefly examined the consumer perception, need of sustainability and sustainable fashion.

As the final result, it was found out that a part of people knows about it and are taking seriously but there are several groups if people still unaware about it and there is a lot that they need to know about sustainability.

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Exploring Consumers' Fit Perceptions and Satisfaction with Online Purchased Garment Fit in Indian Women's Upper Wear

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As clothing is a basic human need, purchase of clothing is usually a matter of creating decision about whether to shop for, what to shop for, when to shop for, the way to shop for and from where to shop for. Each deciding style represents a mental orientation characterizing the consumer's approach to make a choice. The topics were determined for consumer's perception of fit i.e., physical fit, aesthetic fit, functional fit, social context, and social comfort. Fitting problem in the garment affects the purchasing decision of women. This study aimed to explore consumers' fit perceptions and satisfaction with online purchased garment fit in Indian women's upper wear. The study was conducted under 180 respondents in Swami Vivekanand Subharti University, Meerut, age group 18-35 years. The purpose of this study was to develop an understanding of women's overall garment fit satisfaction and to analyse the meaning of garment fit from the women's aspect. The main objectives of the study were to evaluate women's overall satisfaction with the online purchased garment, to evaluate women's perception of garment fit in online purchased garments, and to analyse the possible factors that women reflect in determining if they are satisfied/dissatisfied with garment fit. A self-constructed questionnaire with open and close ended question was formulated to get the information regarding the criteria of selection, satisfaction with the online purchased garment with the help of five rating scale. Random sampling was used where each and every item in the population has an equal chance of inclusion in the sample and each one of the possible samples, in case of finite universe, has the same probability of being selected on the behalf of five rating scale i.e. poor, average, good, very good, excellent. In the result of this study the respondent rated average to poor, to the garment's fit for the online available garment. Thus, on the basis of result it as concluded that the respondent desire for the new series in Indian women upper wear garment.

Keywords: Buying behaviour, Consumer's perception, Indian women's wear, Garment fit and online shopping etc.

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The Barriers to Sustainable Fashion Consumption

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Fast fashion is the latest business model trend in the fashion industry. It provides low-cost, low-quality and trend-based clothing to consumers at unprecedented speed. The fashion industry, therefore, has emerged as the second most polluting industry in the world. In recent years people have become more conscious about the impacts of the fashion industry on the environment. To reduce the environmental impacts of the fashion industry, brands and designers are incorporating sustainability into their products and marketing strategies. Sustainability, therefore, is making waves in the fashion industry. Although the interests in sustainable fashion may have risen over the years, the number of consumers that are interested in and buy sustainable fashion is still small. Previous research has revealed the presence of challenges and barriers to sustainable fashion consumption. This research investigates these barriers that prevent consumers from purchasing sustainable clothes. To promote and increase sustainable fashion consumption, this study aims to identify the most important barrier that prevents consumers from the purchase of sustainable fashion. The main objective is to observe and compare how these barriers influence the attitude and behaviour of different genders towards sustainable fashion. This study depended on literature research to uncover the barriers to sustainable fashion consumption. A survey was performed to find out the significance and influence of these factors towards sustainable fashion consumption of each gender; comparing the attitude and behaviour towards sustainable fashion between men and women. This Thesis contributes to previous studies by explaining about the purchase behaviour of sustainable clothes.

Keywords: Fast Fashion; Fashion consumption; Sustainable fashion; Barriers

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Organic Cottons for T shirt

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Organic cotton is grown using methods and materials that have a low impact on the environment. An organic production system replenishes and maintains soil fertility, reduces the use of toxic and persistent pesticides and fertilizers, and builds biologically diverse agriculture. They are grown with low impact on environment.

As the concept of sustainability and eco friendly sweeps the floor of fashion world, it's time for us to change or die. All fashion brands are looking forward to this concepts, sustainability and eco friendly. The mass production must be reduced and more over the use of organic raw materials and fabrics must be inculcated into the fashion mainstream to overcome the current negative impact we have on our environment. This not only creates an eco friendly environment but also conditions conducive for sustainable life.

So, the use of organic cotton in T shirts can be a relevant example on sustainability. This paper emphasizes on the advantages of organic cottons and natural dyes and acceptance of organic T shirts by the customers. So, with this research I hope that the readers will understand the benefit of organic cotton products like T shirts not only considering the environmental impacts but also on our personal benefit.

Keywords: Organic cotton, Sustainability, Consumer behavior. T shirt, natural dyes.

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Repositioning Indian Crafts in the New Normal: The Need for Contemporary Marketing Post-Covid-19 Outbreak

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Crafts are an integral part of the culture of India. Despite the rapid socio and technological advancement all over the globe, the Indian Crafts are important to the heritage of the rich country, these have been an important commodity for world trade since ancient times. Artisans are the most substantial and manual contributor to the products crafted. The handmade skill of producing these Crafts is what makes it unique, it is like an ocean of cultural-economic diversity. The craft industry is a substantial employer and source of livelihood to these Artisans and it has a considerable contribution to Economic Growth. There are several means of support offered by the Government to them, but still, the craftsmen were thriving to earn a respectable livelihood out of this, which eventually threatens the future existence of the same.

Post COVID-19 pandemic caused widespread shutdown across the globe leading to the decimation of business. The craft sector which is the underlying steel of Indian fashion and textile has been severely affected as well, to the extent of the artisans not even being able to earn the bare minimum cost of Clothing, Food & Shelter. Wherein a lot of businesses have started gearing up, but the huge decline in the sales of the craft sector is hitting hard in rural areas. Most of the crafts are in an alarming situation despite the focus on value for local and Atmanirbhar Bharat. Though these products have equitable potential motivated by 'Skill India' and 'Make in India' initiative, in a world where digital, machine learning and artificial intelligence are taking over manufacturing, these handcrafted products are steadily losing their connection to the common masses. This pandemic has led to a broken chain of supply; no tourism; no exhibitions and decreased scope of crafts. This paper contributes towards promoting the social, economic, and environmental well being in the crafts sector, and rethinking to position the crafts in the digital era of modern-day consumer. It is relevant especially when the consumers have realized the importance of handmade sustainable products and are willing to make sincere efforts, but lack the approach towards the same. The outcome will suggest ways to bridge the connectivity gap between the two through adopting contemporary marketing techniques as required by any business for its growth.

Keywords: Indian Crafts, Atmanirbhar, Digital, New Age Marketing.

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Beatles Fashion: Relevance of Beatles Fashion in the Modern Era

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The Beatles were an English Rock Band of four individuals John Lennon, Paul McCartney, George Harrison and Ringo Starr, which was framed in 1960. They are viewed as the most compelling band ever. Without precedent for nineteenth century London was the focal point of fashion world not Paris. The effect of Beatles cleared into all the pieces of life of British youth, particularly attire. This season of period saw the most extreme experimentation regarding shadings and sizes of attire. By the late 1960s, the Beatles had adopted trends towards more casual fashions, with T-shirts, Blue Jeans and Denim Jackets. Lennon also popularized wearing, solid white suits reflecting minimalistic designs. The Jazz culture was gradually moving towards Rock & Roll and pop culture and they saw the rising popularity of the Beatles. It also influenced teenage subculture a lot such as Mod, Rude Boy, Black Panther, Skinhead and more. My purpose of research is to prove that the influence of fashion trend brought up by the Beatles still exists in primary or secondary (i.e., direct or indirect) manner amongst the teenagers in today's era of digitization especially in music bands. The Beatles were many things simultaneously: they were the most famous celebrities of their times, the best songwriters and ultimately, the most celebrated band of the particular period. The band continued to influence generations, and is still continues to have a profound impact, with the adaptation of technology. This proves that the subcultures which are the part of old times culture will continue to effect fashion and cleanse in a reflective manner but what is needed to be observed and researched is the dramatic advancements in the same.

Similarly, the digital techniques used in fashion industries have been the great influence on the evolution of the Beatles fashion. In other forms we could say the artificial intelligence used in experimentation in fashion industry is still carrying the legacy of Beatles fashion along with the changes of trends and time. Experimentation is the key to developing and forming new insights that help you innovate fast. Two-thirds of the professionals that were interviewed as part of our survey mentioned that they provided plenty of room for natural and thorough experimentation. However, one in five organizations from the education, telecom, and public sector wasn't open to the idea of testing regularly. The organizational plan, I'll be using for my research will be accumulating all the relevant data and evidences and by surveying among the teenagers as well as music bands in order to prove my thesis. This research will be beneficiary for the consumers who admire Beatles Fashion. I'll be collecting all the information about the existence, evolvement and relevance of Beatles Fashion in current scenario.

Keywords: Beatles Fashion, Evolution, Digital era.

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