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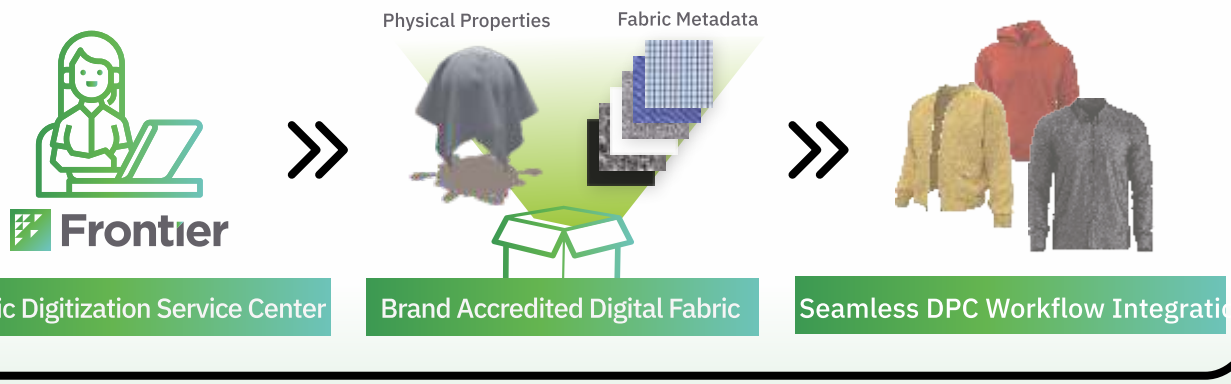

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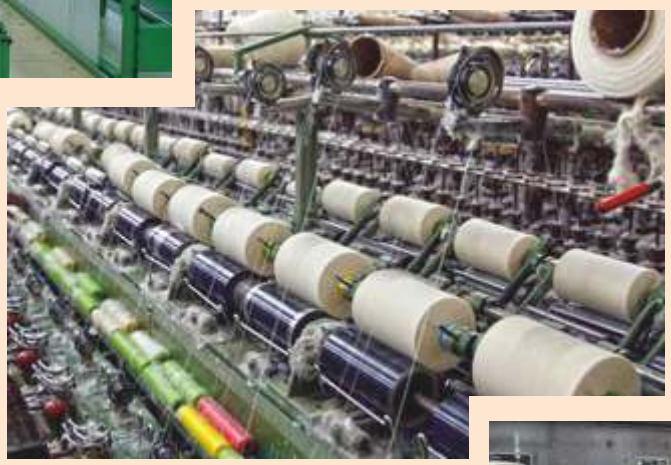

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India Shines Bright with Prosperity and Glory

Dr. Chet Ram Meena
Guest Editor
NIFT Jodhpur, Rajasthan

India is a country with a long history and has seen many notable events that through time have changed its cultural, political, and social landscape. India is a fascinating example of progress because of its contributions to classical arts, yoga, science, and a variety of religious systems. India is commemorating "Azadi Ka Amrit Mahotsav" to mark the nation's 75th anniversary of independence as well as the illustrious past of its people, culture, and accomplishments. Through coordinated initiatives and global outreach, the 77th year of Independence intends to further strengthen the people's movement in India and around the world. Activating India 2.0 is Prime Minister Narendra Modi's goal, and it is inspired by Aatmanirbhar Bharat. To accomplish the innovative objectives and leave a lasting impression on the world through the deed.

The Group of Twenty (G20) is the main setting for economic cooperation on a global scale. On all significant international economic issues, it plays a significant role in forming and strengthening the global architecture and governance. It comprises the biggest economies of the globe and represents a wide range of countries, from established powers like the United States and China to emerging ones like India and Brazil. The G-20's importance in solving urgent global issues like economic stability, climate change, and public health concerns while noting both its successes and shortcomings. India holds the Presidency of the G20 from 1st December 2022 to 30th November 2023. The G20 countries were urged by Prime Minister Narendra Modi to work together toward a future in which culture serves as a catalyst for social inclusion, sustainable development, and international harmony in addition to being a component of our national identity. The talks and deliberations on the priorities outlined by India's G20 Presidency that have taken place as part of the Culture Working Group Meetings and the Global Thematic Webinars, according to the PM, have been both astonishing and inspiring. He asserted that by pooling our knowledge and taking responsibility for one another, we may turn the issues before us into chances for worldwide cultural advancement. India is currently viewed as a blend of openness, opportunity, and options, according to PM Modi, who also emphasized the international optimism and confidence in the Indian economy. He said that India had moved up to the fifth-largest global economy in the past nine years thanks to the "Reform, Perform, and Transform" program. The prime minister recapped how programs like Make in India and Aatma Nirbhar Bharat have boosted manufacturing while also mentioning the stability of the country's policies. The administration is dedicated to make India the third-largest global economy in the coming years, he emphasized. The G20 commerce and Investment Ministers' Meeting was held in Jaipur, Rajasthan, on August 24, 2023. In his opening remarks, the PM stated that it was "our responsibility as G20 nations to rebuild confidence in international trade and investments." As a game-changer that will democratize the digital marketplace eco-system and have the ability to improve market access, PM Modi mentioned the "Open Network for Digital Commerce."

The G20 is still a vital venue for discussing urgent global issues, but it has its limitations. Its capability to adapt, promote collaboration, and give priority to equitable solutions will determine how it can influence the future. The G20 understands that, despite its history of achievements, there is always room for reform and adaptation to meet new challenges.

The five largest emerging markets and developing nations that make up the BRICS cooperation were brought together because of their similar interests and enduring friendships. BRICS stands for Brazil, Russia, India, China, and South Africa, which together account for approximately 42% of the world's population, 30% of its territory, 23% of its GDP, and 18% of its trade. Johannesburg, South Africa hosted BRICS 2023 from August 22–24. These nations collaborate on a range of global challenges, including as economic, political, and strategic ones.

In highlighting the bilateral ties between the two nations, PM Modi stated that India has given its relations with Africa a high priority. He also emphasized the importance of the priorities and issues of the Global South and the path forward for ensuring that international institutions and fora are inclusive and representative. In

addition, PM Modi mentioned that India is currently Africa's fifth-largest investment country and fourth-largest trading partner. According to him, "India has always given priority to the capacity building and infrastructure development of African countries." The PM emphasized that India is a dependable and close ally in the effort to make Africa a future global powerhouse in accordance with Agenda 2063. He reiterated India's proposal to grant the African Union permanent membership in the G-20. On January 1, 2024, the additional invitees are expected to join the BRICS as full members. He declared, "India has always thought that the admission of new members will further strengthen BRICS as a group and it will provide a new impetus to our joint efforts. The PM continued, "I believe the BRICS countries and the friendly countries here can strengthen a multipolar world."

On August 23, 2023, at 6:04 p.m., the Vikram Lander from the Indian Space Research Organization (ISRO) made a successful soft landing on the south pole of the moon. On July 14, ISRO launched its lunar lander, and since then, the space agency has been disclosing details on the significant space activities the lander endured. This project is considered essential for lunar exploration and strengthening India's position as a space power. India made history by being the first nation to successfully land the Chandrayaan-3 spacecraft on the south pole of the Moon. While attending the BRICS conference in South Africa, PM Modi raised the Indian flag as he watched the plane arrive.

Our unwavering dedication to advance space research and technology is demonstrated by this mission. It will build on the knowledge we have gained and the achievements we have made. Our knowledge of the Moon's geology, mineral resources, and possibilities for further scientific and technological investigation will be improved by Chandrayaan-3's lunar rover landing. It's an important step in the direction of our mission to explore the Moon and use its resources for the benefit of humanity.

On August 26, 2023, PM Narendra Modi addressed the ISRO scientists in Bengaluru and made several significant announcements. He has declared that the spot where the Vikram Lander and Rover Pragyan touched down on the surface of the moon will be known as "Shiva Shakti" point and that it will serve as a symbol of India's advancement, cohesion, and hope for a better future. According to him, the Shiva Shakti point will serve as a reminder of Shiv, who devotes himself to promoting the welfare of humanity, and Shakti, who provides the innate power to carry out this goal and tends to do so. Additionally, the PM declared August 23rd to be National Space Day. His speech struck a chord with the nation's youth, motivating them to pursue scientific investigation and discovery. The country's youth were also given a responsibility by the PM. He declared, "I want the new generation to go up and scientifically demonstrate the astronomical formulas in the Indian scriptures, to study them once more. We have to investigate this treasure in this Azadi ka Amrit Kaal as well as spread the word about it.

Jai Hind!

Mr. R. K. Vij, President - TAI

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R. K. VIJ

We celebrated our 77th Independence day on 15th August 2023, marking 76 years of freedom. On this occasion the Hon'ble Prime Minister Shri Narendra Modi ji congratulated the nation and paid tribute to independence heroes.

The Prime Minister stressed that corruption, nepotism and appeasement are the three evils that the country is facing and called for getting rid of them, so that the country can progress in its journey to become a developed nation. PM urged to shift focus from nepotism and dynasty. He called for decisive action against corruption and 'Parivarwaad ' (Dynasty politics). Familism has taken away the rights of the citizens of this nation. The third evil that has stained the image of India is appeasement. He said to fight against all three evils with all of our strength.

Our country can also grow very fast in Textile if our exports grow faster than imports. The sudden Textile growth in Small Countries like Bangladesh and Big Countries like China came only by increasing their exports. A small country Bangladesh where there is no major raw material available and even not having a big captive consumption but still growing by increasing Textile Exports on year to year basis".

Country philosophies should be only to concentrate more on export of value added textile products. See big country like China, in spite of having big captive consumption China is still not number 1 in export. Whenever their export reduces, their production capacities start falling.

Indian Govt. has also realised that if we have to grow in Textiles and also to become like China, then we have to reduce imports and increase exports. The Director General of Foreign Trade, Ministry of Commerce & Industry suggested that in order to achieve the projected exports of USD 1 trillion each in Merchandise and service by 2030. It is important to achieve overall CAGR of 14.47% including merchandise CAGR of 12.05% and service CAGR of 17.39%. The Hon'ble Prime Minister has proposed a 3 T strategy focusing on Trade, Tourism and Technology to strengthen Indian diplomacy. This can be done by utilising India's overseas mission and embassies. India should import less and export more. We should explore the favourable export destination by utilising the infrastructure provided by the Government. We should rationalise our Custom Duties. There should be less Custom Duties on the basis of raw material and more on value added products in place of keeping the same custom duty on raw & value added products. Cotton should be also available in India at International prices because cotton also plays a greater role in increasing value added products like garments. All basic raw materials like PTA/MEG/Viscose/Cotton should be available at International prices.

The 2nd Point is our trade and investment policies form the back-bone to enhance the growth trajectory of any economy. We should focus on skilling and imparting relevant skills to enable quality products for promoting exports of indigenous products.

The 3rd point is FTAs between India and other national economies. Govt. is very aggressive to do FTAs with more countries. The Production Linked Incentives (PLI) scheme will drive exports growth in India. Indian Govt. has invested huge in infrastructure which will give a multiplier effect in growth of exports in coming years. FTA with UK and Europe will be a great advantage to boost Indian Exports. Our Central and State Textile Ministers are doing a great job to increase Indian Textiles.

The 4th point is that we should restrict cheaper downgrade materials imports. Govt. has come with mandatory QCOs in certain products to restrict import of downgrade materials. Govt. to start QCOs from downstream products also very fast instead of upstream products. If we will do mandatory QCOs on basic raw materials, then imports of value-added costly materials will start coming to India. Let, suppose, earlier we were importing basic raw materials at lower price and after mandatory implementation of QCOs on raw materials then import of a value added product will start coming and losing more foreign currency. By this way we will save foreign currency and will also boost Indian Industries. o it is suggested to the Govt. to first start mandatory QCOs on downstream products and then go to upstream.

Govt. has fixed to achieve the total textile trade target of USD 100 Billion by 2026/2027 from the present of USD 44 Billion. We should all join hands together to achieve this target.

किसी ने सही कहा है अगर सब कोई लक्ष्य को प्राप्त करना चाहते है तो सब मिल जावो . पहले अपने साथी की सोचो अगर वो आगल निकलता है तो आप अपने आप आगल निकल जाओगे . वह दिन दूर नही होगा जब हमारा भारतवर्ष भी निर्यातमे नंबर १ होगा .

JAIHIND!!!

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Adoption of Cloud Basics in Small & Medium Enterprises (SME)

Vikas R. Gangadhar* & Ashwin Tomar

MIT College of Management, MIT ADT University, Rajbaug, Loni Kalbhor, Pune

Abstract:

Small and Medium Enterprises (SME) plays a pivotal role in stimulating economic growth and creating jobs, largely due to their unique selling propositions (USPs). Given their limited budgets, they often focus on survival through their USPs, side lining the adoption of advanced technologies. Cloud technology, however, is ushering in a wave of benefits for these businesses, who otherwise struggle with substantial IT investments.

Characterized by scalability, rapid deployment, agility, elasticity, and a pay-as-you-go model, cloud technology is a more feasible alternative to traditional in-house IT setups. This new-age technology is benefitting companies greatly, establishing itself as an ideal IT solution for SMEs. The need for in-house IT expertise is negated as the cloud provider assumes a significant share of the deployment and operational responsibilities. Expertise offered by cloud service providers helps SMEs extract greater value from their technology investments, letting them concentrate on their core competencies to enhance their services and operations.

Cloud providers, on the other hand, also reap benefits due to economies of scale, and assured loyalty and commitment from their customers through lock-in periods. For optimal results and a trust-based relationship, cloud providers and SMEs must work together to identify the most fitting cloud offering. This collaboration will primarily aim at enhancing mutual business outcomes. The cloud services have already demonstrated their effectiveness during the COVID-19 lockdown situation. The study provides an overview of cloud technology basics and its strategic advantages for SMEs.

Keywords: *Cloud Basics, Cloud Adoption, Cloud Technology, IT strategy, Small & Medium Enterprises*

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1. Introduction

Small and Medium-sized Enterprises (SMEs), also known as Small and Medium-sized Businesses (SMBs), hold a critical position in the economic landscape [1]. They are powerhouses of job creation, innovation, and contribute significantly to the nation's fiscal growth. In a country like India, SMEs are a primary employment source, employing 40% of the workforce. Famous for its innovative spirit, India witnesses many of its small businesses crafting novel products, services, and business frameworks that stimulate economic expansion. SMEs also constitute a substantial part of the nation's export revenue, with a myriad of small businesses participating in export-driven sectors such as IT, textiles, handicrafts, and pharmaceuticals. These enterprises are crucial to the economic progression in rural areas, where many of them are situated. Being deeply entrenched in their local communities, these businesses have a positive social impact. They not only offer job opportunities but also support local suppliers and invest in community development initiatives.

There are several issues that SMEs in India. SMEs in India often face challenges in accessing finance, this can limit their ability to invest in new equipment, technology, or marketing campaigns, and can hinder their growth prospects

They face stiff competition from large enterprises, which may have more resources, economies of scale, and established brands. SMEs often struggle to find and retain skilled employees, particularly in areas such as technology, engineering, and management. COVID-19 pandemic, in the beginning of the year 2020 has impacted business across globally by slowing down the economy. This has invited plenty of problems for SMEs.

Overall, addressing these issues will be important for the growth and success of SMEs. To remain competitive in the domestic and international trade markets, SMEs need to continuously upgrade themselves against emerging challenges such as technology changes, changes in demand patterns, and new business innovations.

To overcome some of the challenges by SMEs. Cloud technology with its numerous benefits is perfect solution for them. Cloud computing eliminates the need for SMEs to invest in expensive hardware and software and allows them to pay only for what they use. This can help SMEs save a significant amount of money, which can then be reinvested in other areas of the business. Cloud computing allows SMEs to easily scale up or down their IT resources according to their needs. This means they can quickly respond to changes in demand,

In totality, cloud adoption can help SMEs to be more competitive, agile, and efficient in today's fast-paced business environment.

The technology if we don't use properly then it became liability and hence it is not only important to adopt newer technology but assess them whether they are really providing expected benefits. This article discusses some of the aspect of technology adoption for SMEs.

1.1 SMEs definition

Small and Medium Enterprises (SMEs) is also called Small

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and Medium-sized Businesses (SMBs). These are the business entities which fall under a specific range criterion based on their number of employees, revenue, and assets. The definitions of SMEs can vary across countries, but there are some common characteristics that help categorize them such employee size, revenue or turn-over asset size.
In Indian market, they are mainly classified in the two groups [2].

- Product Focused: organizations producing good or engaged into manufacturing activities.
- Services Focused: organizations offering services as their core business.

The governing agencies are working to remove the blockages and smoothen challenges to provide healthy eco-system for regional SME developments. In our country, the SMEs are classified based on their investment profile or based on their turnover in financial year. The new classification has expanded the boundaries to offer assistance to large population as depicted in table 1.

Table 1 - New definition of MSME (https://msme.gov.in/know-about-msme)

Category	Micro	Small	Medium
Product and Services Focused	Investment in Plant and Machinery or Equipment: Not more than Rs.1 crore and Annual Turnover; not more than Rs. 5 crore	Investment in Plant and Machinery or Equipment: Not more than Rs.10 crore and Annual Turnover ; not more than Rs. 50 crore	Investment in Plant and Machinery or Equipment: Not more than Rs.50 crore and Annual Turnover ; not more than Rs. 250 crore

The cloud computing has five essential characteristics, three service models and four deployment models [3] as depicted in the below figure 1.

1.1.1 Essential Characteristics

a. Demand based self-provisioning feature
An end user can place requests for the provisioning of cloud resources such as Virtual Machines, file storage, and network by himself. The on-demand provisioning happens without human interaction with the service provider, automatically with a few clicks of a mouse. The on-demand service has brought up a lot more flexibility and agility in the whole provisioning process. [4].

b. Broad network access
The cloud resources can be accessed using any thick or thin front-end client from any device such as mobiles, laptops, tablets, and desktops. Most of the cloud utilities are hosted on the public cloud and reachable round the clock through varied front-end devices [5].

c. Resource pooling
Pooling is an important features of cloud computing of resources for shared access for multiple subscribers. These assignment and reassignment of resources happen dynamically based on consumer's demand. The resource allocation of resources such data storage, processers, memory, and network happen through abstraction layer and consumer might know the region or country at most from where these services are allocated. Resource pooling essentially save lots of energy by optimizing provisioning of resources on need basis [6].

d. Rapid elasticity
Computing resources are getting elastically scaled up and down based on certain triggers automatically or based on demands. For the consumer, the resources provisioning capabilities make availability of computing resources just-in time with required quantity by optimizing resource usages [7]. Best example is of commercial website which need to be scaled up with computing resources during flash sales and scale down for off season sales.

e. Measured service
The utilization of cloud resources are monitored, measured and reported to both the parties i.e., supplier and consumer for transparency reasons. The measurement units might be number of active users, number of processers or memory units, network bandwidth allocation, storage usages or number of computer instructions which are metered to some abstraction layer as unit or service offering charges in the form of rent [8].

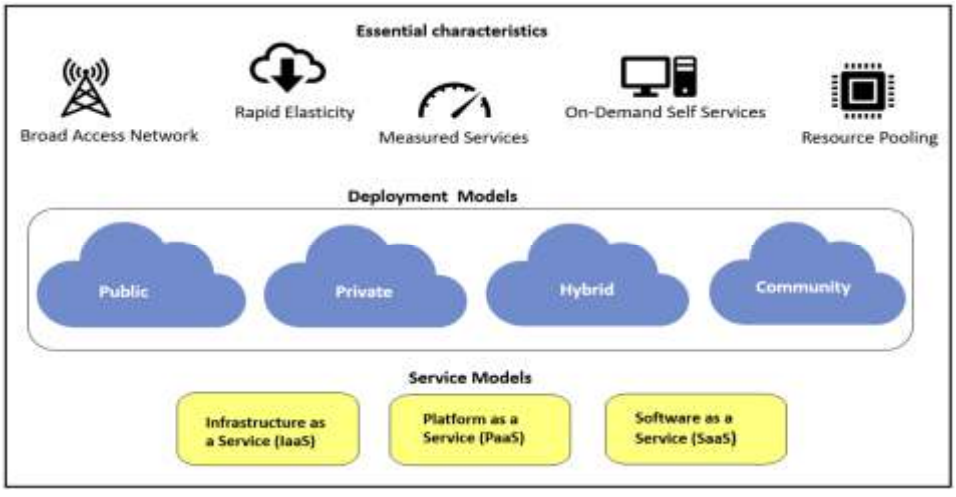

Figure 1- NIST Model of Cloud Computing

1.1.2 Service Models

Even though the lines between the three service models are blurring, they are now commonly used in existing cloud computing.

i. Software as a Service (SaaS)

It is complete offering from cloud provider in which consumer will access them using front end technology and pay for licensing cost or pay based on transactions. These packages are covering standard offering suitable for multiple clients from specific domain. Consumer has very less opportunity to customize them. The underlaying computer resources are managed by supplier. This is a model where the vendor controls every aspect such as bug fixes and upgrades [9]. This category includes many enterprise apps, including Success Factors from SAP, CRM from sales force, and others.

ii. Platform as a Service (PaaS)

The platform is hosted by cloud provider typically called as middleware. The consumer does not manage hardware, operating systems and middleware software. It is responsibility of cloud provider to provide high available and stable platform for hosting business application developed and managed by consumer organization. The bug fixes and release upgrade for business application will be managed by consumer in conjunction with supplier underlying platform from compatibility and performance perspective. This offering covers multiple diverse scenarios and not easy to manage without full stack knowledge and expertise in multiple areas [10].

iii. Infrastructure as a Service (IaaS).

This is a foundation service offered to the end user to consume computing resources for hosting business application with essential runtime environment (OS and middleware layer). The consumer has to manage and had most control over platform and business applications. The underlying hardware and network resources are managed by cloud service provider. This is the foundational offering of cloud computing service model where consumer is responsible for installation and management of software stack [11].

Apart from these three classical service models, there are new category of service offerings which falls between the two service models. Serverless computing and functions are new features where the piece of code is executed for specific actions based on event-based triggers. In a nutshell, the cloud service offering descriptions are intractable based on their usages and purpose [12].

1.1.3 Deployment Models

Cloud infrastructures get deployed in a variability, or more precisely, they can be accessed in a variety of ways. Different types of clouds are specified by the deployment models.

- ***Private cloud***

The cloud services which is made available for usage one company or business units of same company for their private use. It may exist on or off premises. It's ownership of management and operation either remain with company by themselves or with help of service provider or it may be combination. Sometime cloud services are made available through a private network without using internet platform to handle company's data in more secured way [13]. This is not a common pattern and depend upon organization to organization due to their regulatory, or data privacy and security compliance reasons. Private cloud is merely another method of managing online data centre.

- ***Community cloud***

Particular group of customers from businesses that share similar issues have access to the shared cloud infrastructure supporting their shared requirements in term of security compliance and regulatory policies or common project objectives. It can also be called hybrid form of private and public clouds. The ownership responsibility of community cloud may remain with community or with service provider or both are partially involved in combination [14].

- ***Public cloud***

The public can use the cloud infrastructure without restriction. A commercial organization, academic, or governmental body, or in a combination, may own, administer, and run it. It is present on the cloud provider's property. This is the well-known common model. This strategy is largely used today to deploy cloud computing. This is accessible and usable via the open Internet. Initially, a large number of people raised security concern due to shared resources but data encryption in transit and at rest may have improved their perception and authenticity of public cloud [15].

- ***Hybrid cloud***

The cloud deployment model which is made up of two or more different cloud models is called hybrid cloud. The some of the inherent characteristics and feature of secluded, communal, or public clouds are continuing to exist in as a separate entity as a hybrid cloud form. The hybrid cloud is most popular form in commercial organization as they can use the cloud technology and it's benefit to their advantages depending upon the use case [16]. Some of the examples are storing more critical data over private cloud from security perspective while less secure data go over public cloud. Another best example of load balancing, increasing resilience, and high availability of services using a hybrid cloud platform from multiple vendors.

2. Choosing the IT strategy for SMEs

SMEs primarily concentrate on their unique selling proposition (USP), with less emphasis on technology for their IT functions. They anticipate every technological investment to amplify their market presence. This technology utilization should assist them in tapping into untapped potential, which is currently limited due to factors such as consumer purchasing behavior and internal agility to meet unforeseen business demands. Those companies that are already employing IT operations are keen to enhance their business performance. In both scenarios, the organization's goal is centered on business agility and profit augmentation.

The challenge lies in adopting an integrated approach to the information technology strategy that addresses business challenges and yields sustainable business results. The organization must formulate an effective IT strategy that not only achieves business goals but also encourages technology usage among its stakeholders. The business drivers influence the IT strategy. There are six main key consideration one should focus while laying down IT strategy for SME organizations [22].

- How it helps for increase the market share.
- How it assists for practicing world class process and operational standards
- How it helps to bring efficiency and reduce the cost burden
- How it assists against business uncertainties
- How it remains competitive from future perspective
- How much is the total cost of ownership (TCO)

The alignment of business and IT strategies is crucial for yielding superior business outcomes. The function of Enterprise Architecture (EA) aids in converting business strategies into IT strategies, employing established methodologies, tools, and techniques in the planning process. Regrettably, SMEs often lack in-house IT specialists, necessitating dependence on external expertise. Previous research illustrates that SMEs have sought the assistance of external consultants, IT professionals, and IT vendors to formulate their IT strategies. These external IT professionals and vendors play a critical role in implementing information technology infrastructure within SMEs. Sometimes, issues can arise if these external teams fail to understand the specific needs of SMEs. Conversely, vendors with a robust technological footprint that assist SMEs with their marketing strategies are more aware of global challenges and their solutions. They introduce elements of quality, identify training needs, and ensure the sustainability of IT setups and operations. This encourages SMEs to implement top-tier IT solutions to boost their business performance [9, 10].

The duties assumed by these external IT professionals encompass IT project management, requirement analysis, design blueprinting, hardware and software provisioning, and encouraging end-users to familiarize themselves with new systems. These external consultants or IT specialists act as intermediaries to compensate for IT skill shortages in SMEs and facilitate the successful implementation and usage of information technology functions.
Cloud Technology, with its numerous benefits, has emerged as a trend and has been a lifeline for SMEs during the challenging times of the pandemic. The adoption of cloud technology transcends just a technological platform. It's essential to create a compelling value proposition when crafting a cloud adoption strategy. Here are some of the typical considerations for SMEs adopting cloud technology. SMEs looks forward to use emailing solution (Software as a Service) and storage (Storage-as-a-Service) to begin with at smaller stake over big enterprises.

The cloud hosted certified hardware and software with regulatory compliance will be a motivational factor for meeting the regulatory provisions. Cloud provides control over purchase. You can limit the usages or rent a service for required duration. This is much beneficial option for SMEs. Cloud service provider offer customization services tailoring to your business requirement. The benefits SMEs as sometimes they lack in internal IT capabilities.
Cloud service provider are partnering with multiple vendors providing the best offering for you under single window. Cloud provider are also benefited due to economy of scale.

3. Preparing cloud strategy for SMEs

We can outline various stages in defining cloud strategy for SMEs driven through collaborative efforts between business and IT teams. This includes proven method to formulate and validate your strategy. Enterprise architectural function comprised by internal business team and inhouse or external IT staff will identify, prioritize cloud use case, create a roadmap, and formulate governance for cloud adoption. This is iterative process handled through agile methodology for continuous improvement. Each stage builds new capabilities upon previous stage and utilize the lessons learned from earlier stages.

3.1 Vision

The strategy for cloud adoption should have mission and vision statements that will set the direction. This will be common language across all the stakeholders and assist to understand the big picture. Definition of cloud technology has pursued from various perspective, the most common view about cloud services as an IT enablement technology using internet connection for hosting virtual landscape which brings high level of automation, speed, agility, elasticity, and cost saving options [17]. The next step is to find an opportunity to increase business value by means of technology usages. The vision statement should allow innovation and provide direction for achievement end objective [18].

3.2 Use Cases

The outcome-based scenarios are typical called out as cloud usage cases. This is illustration of ways the cloud computing is adopted to realize the benefits. e.g business process optimization, skill enhancement, process re-engineering, re-plat forming, usages of emerging technology such big data and AI for supply chain improvement [19]. The use case need supporting business drivers and right mapping of key stakeholders.

3.3 Innovation

Cloud technology itself is an innovative technology and provides multiple deployment options. The technology provides tool and techniques to overcome typical challenges and issues arriving during business innovation. The technology is helping to anticipate potential challenges, try to simplify complexities and assisting in expedite problem resolution. Cloud technology provides wider levers for business innovation which are out of reach for SMEs due to lack of budget, IT expertise and experience in those areas [20].

3.4 Projected ROI and TCO

There has to be focus on business values while preparing cloud adoption strategy. The business values can be brough by many means such as IT cost reduction or process optimization to increase financial benefits [5].

Returns on investments (ROI) defines the efficiency of financial outcome over investments. This is a key measure for cloud deployment business case. Another financial aspect is total cost of ownership (TCO), your strategic benefits should remain relevant in the future. This need market research for your business use case,

Cloud service provider will assist you in identifying your investment requirements and TCO for years to come.

3.5 Technology Offerings

The cloud service providers take benefits of economy of scale and provide best technology options for their consumers. The consumers need not to worry about maintenance of product and services, they will have to pay based on pay as you go metered services. The Software as a Service (SaaS) offering provides many benefits for SMEs compared IaaS and PaaS.

3.6 Ecosystem

Consider cloud technology adoption as means of achieving short term and long terms objectives. You may start with small services such as shared storage to email applications. You may prepare for advance deployment options which will bring business values at each level of adoptions. SMEs need to choose cloud supplier carefully who show greater interest, holds credentials and play a role of strategic IT partner. Cloud provider is bringing lots of experience and best practices around integration, process adherence and regulatory compliance. The matured relation among the stakeholders will benefits everyone for their own means. Hence developing ecosystem within organization along with key stakeholder and outside alliances during cloud adoption journey playing important role for growth of SMEs [18].

3.7 Stakeholders

The strategy preparation is act of management function, but it needs open minded close co-ordination and communications among teams. The identification of right stakeholders for preparation and evaluation cloud adoption strategy is very important for its success. If you manage to involve your business stakeholders, suppliers and consumer of services actively in the strategy evaluation and building process then your strategy will be more effective and sustainable. The continuous engagement of these stakeholders is also essential for developing long lasting, value driven cloud adoption strategy [13].

3.8 Metrics

The metrics provide you means of measuring effectiveness of your cloud adoption strategy. You must have deeper understanding of your existing business key performance indicators and link inference of cloud adoption to them. Each of metric should be measurable and it should clearly call out the impact over business outcome. You can define further metrics for your availability, uptime and turnaround time for your services [12].

3.9 Governance

The effectiveness of cloud strategy remains on quality of governance around it. The implementation of governance will ensure consistency across data usages, adoption of integration patterns and compliance policies. Your cloud strategy should be subset of your enterprise's governance. Governance should establish decision making process and the key roles who are authorized make decisions during predefined or unforeseen circumstances. The steering committee establishment and their collaboration with stakeholders assist to establish effective governance around cloud adoption strategy. The governance model assists for planning and refinement of roadmap of cloud journey.

3.10 Roadmaps

The driver for roadmap preparation is to start initiate the groundwork and lay down foundation for technology usages to realize the cloud vision. The roadmap helps as a reference baseline for implementing and tracing the cloud strategy. The roadmap helps to establish cloud strategy aligned to organization's technology, communication and business strategy focused on effective business outcomes [20]

The roadmaps include activities to be performed on timescale along with milestones and measuring key success criteria. The matrices pay key role in measurement of these success factors and assist in necessary adjustment for making the cloud strategy relevant from business outcome perspective.

According to Michael Warrilow, research vice president at Gartner, "the move to the cloud has only accelerated over the last two years due to COVID-19, as organizations reacted to an emerging business requirement." Gartner report published in year 2022 predict that the IT spending of enterprises on cloud will surpass over traditional IT budget in 2025 [23]. The organizations which miss to adopt cloud technology will observe low growth or even in risk of losing business. Figure 2 shows trend in sizing cloud shift during 2019 to 2025 across the world.

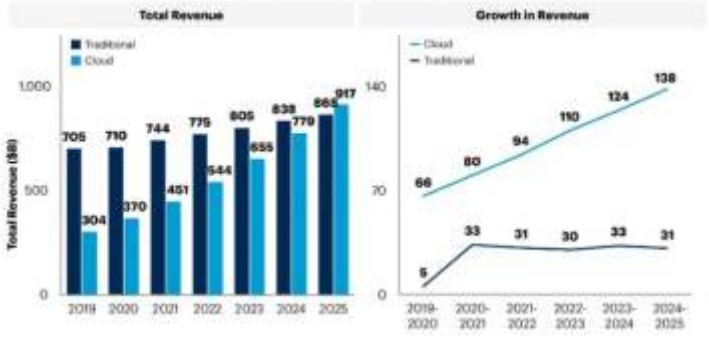

Figure 2 – Worldwide Sizing Cloud Shift during 2019 – 2025

4. Conclusion

In the current era of globalization, businesses grapple with shifting demands. Survival without the adoption of emerging technologies is implausible. Cloud technology, characterized by its scalability, ease of adoption, and cost-effectiveness, is a clear choice. It fulfils enterprise IT requirements and aids in

achieving business goals. A cloud adoption strategy should delineate the value proposition, the chosen deployment model, appropriate service offerings, risk mitigation plans, cost implications, and a vital strategic roadmap. Agile cloud adoption strategies, relevant for the future, need to be based on market analysis.

Effective cloud adoption calls for commitment from the senior leadership team. Disciplined efforts, timely decision-making, and handling exceptions through a dedicated governance process are essential for successful deployment. A strong partnership with a cloud service provider and a diverse cloud deployment model can help mitigate business risks. An effective cloud strategy should leverage key benefits of cloud technology, like 'pay as you go' pricing, swift infrastructure provisioning for immediate use, and on-demand scalability. These benefits can increase business agility and positively influence an organization's ability to respond to market changes.

However, due to a multitude of service offerings and a lack of technical expertise, SMEs may find it challenging to choose the right cloud adoption strategy. The approach discussed in this paper aims to guide SMEs in making informed decisions, maximizing return on investment, and maintaining a low total cost of ownership.

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TECHNICAL TEXTILE

Digital Financial Inclusion: An Experimental Study among Weavers

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Abstract:

The textile industry has vitally contributed to the economic growth of India. In the past, India was identified as a major textile exporter to the rest of the world. Due to mechanization, the concept of hand weaving was reduced gradually. Further, the weavers are struggling due to various financial and health issues. The Government of India, to uplift the weaver's community, announced various financial schemes. The objective of the research paper is to propose a unique conceptual model to study digital financial inclusion among weavers. The study is significant since it is helpful to investigate mobile payment adoption and implement remedial measures. The research will mainly focus on barriers to mobile payment adoption and degrees of resistance. The proposed empirical research study should concentrate mainly on Generation X, the age group of 40-60 years, as the youngsters are inclined towards the adoption of new technologies. India is the relevant geographical region for this study since it is an emerging economy and has witnessed exponential growth of mobile payment in the recent past. Again, the study can yield significant empirical results as a value addition to the present literature in the field of mobile payment adoption.

Keywords : *Digital Financial Inclusion, Experimental study, financial issues, Indian weavers, and Mobile Payment Adoption*

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1. Introduction

The Indian handloom sector is unorganized and an important contributor to the Indian economy. The Indian handloom industry holds excellent artisanship to represent and conserve pulsating Indian culture. India's handloom weavers are recognized worldwide for their weaving, hand-spinning and printing excellence. They are residents of small Indian villages and transfer skills to the next generation. India's largest cottage industry is the handloom industry, with approximately 23.77 lakh looms. This industry offers employment to more than three million people directly and through ancillary activities. In rural India, the Handloom industry is considered as largest employment provider next to agriculture. The environment-friendly, not capital intensive, low power consumption and flexibility to match the market are the advantages of the Indian handloom sector. As per Handloom Census 2019-20, this industry offers employment to 3,522,512 weavers and allied workers in India. Again, 72.29% of the handloom workforce is predominantly occupied by women.

1.1 Government initiatives

1.1.1 National Handloom Development Program (NHDP)

This program has various components to emphasize on different phases of the handloom business. The financial assistance to clusters is provided by Cluster Development Program (CDP). Around 66 clusters received financial support during 2021-22 out of CDP initiatives. Further, marketing assistance and awards to handlooms, haats scheme in Urban are initiated by GoI to support the handloom industry in India. Financial assistance of 30 Crores to 10,000 handlooms is planned by GoI for Megha handloom clusters.

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1.1.2 Market access initiative (MAI)

It was initiated in 2018, reformed in 2021, and will be in force till 2026. This scheme will play the catalyst role in promoting the sustainable Indian exports. International marketing, capacity building, statutory compliance support, conducting studies, evolving projects, offering foreign trade portals, etc, are the major activities under this initiative.

1.1.3 The Handloom Export Promotion Council (HEPC)

It was established in 1965 under the Ministry of Textiles to support and promote all products and fabrics produced by Indian handloom. It conducts market studies, circulates information, provides recommendations to governments, and offers export consultancy. It periodically conducts buyer-seller meets and international-level trade fairs in India and overseas.

1.2 Need for the study

The present era is the digital era, and E-Commerce is the most preferred mode of purchase by Indian consumers. E-Commerce can fetch manifold benefits like convenience etc., to consumers. It grows exponentially every day. An important part of E-Commerce is digital payment via mobile. The UPI is most used for mobile payment among vendors and online consumers. In addition, everyday purchases like groceries, vegetables, etc., can be made via UPI. On the other hand, the currency is the most used payment mode by retail consumers. The currency and coins act as a carrier of transmittable diseases since it carries a large quantity of microbiological organisms. The mobile payment can help to avoid currency and associated problems too.

The researchers have given considerable attention to mobile payment adoption by consumers. The research studies highlighted substantial differences in technology adoption among different generations. In spite of being good at technology, Generation X exhibits a comparatively slower rate of adoption than Generation X and Z. Thus, the slower

adoption rate of Generation X is the research problem of the study.

2. Literature review

When a consumer purchases products or services, he can choose to pay through digital cash (i.e.) if the Smartphone with the internet is used for digital cash transactions, then the process is defined as Mobile Payment Solutions (MPSs) [1]. Examples of MPSs are net banking, mobile banking, and mobile wallets. Examples of mobile wallets are Paytm, PhonePe, Freecharge, Mobikwik, Google Pay, Amazon Pay, Airtel Money, etc. The mobile wallet is predominantly used by customers to pay for their purchases. The scope of mobile wallet is growing beyond retail transactions and is used for one-to-one cash transactions too. In fact, the mobile wallet has contributed a lot to the exponential growth of e-commerce and online shopping. The mobile wallet can provide multiple advantages like convenience, fast, and cost-effectiveness in digital transactions. In spite of all these benefits, the mobile wallet adoption is not widespread except few early innovators. The slow adoption of mobile wallets is a common phenomenon across all countries, irrespective of their economic development. Scholars have studied the influence of behavioural beliefs, trust, perceived security [2], and other variables in mobile wallet adoption. But comparatively, the research studies on the slow adoption of mobile adoption are few.

Most of the research articles on mobile wallets tend to study the factors influencing the adoption of mobile wallets [3]. Few studies are focused only on developing a conceptual model to study the mobile wallet adoption. Few researchers have examined the influence of exclusive factors on mobile wallet adoption (i.e., trust and information sharing, addiction to smartphones etc.) . The TAM (Technology Acceptance Model) is the most used theoretical framework. Further, theoretical frameworks such as UTAUT (Unified Technology Acceptance and Use of Technology), TPB (Theory of Planned Behaviour), IDT (Innovation Diffusion Theory), and TRA (Theory of Reasonable Action) are commonly used to develop a conceptual model and test the model empirically. But the consumer resistance of MPS is a less focused research area. The research article "The Barriers to the Adoption of E-Wallet Payment System" investigates the barriers to the adoption of an E-Wallet payment system using the IRT theory model . Another research article, "An innovation resistance theory perspective on mobile payment solutions," tries to identify which IRT barriers are significant in the context of MPSs. Again, it tries to answer the second research question, "How do these barriers that existed prior to the adoption impact the future use and recommendation intentions of first-time MPS users" [4]?

As per the literature review, the slow adoption occurs mainly due to consumer resistance [5]. It is very common for retail innovations to face consumer resistance. But few innovations fail during the resistance phase, and successful innovations will sail through it. Resistance is a usual reaction towards potential innovations which can change the lifestyle and modify the present form . For example, the introduction of personal computers too had resistance in the beginning, but it successfully completed it, and today, PC has become essential for life. The firms offering innovative products/services, especially in digital solutions, should recognize that consumer resistance is a vital factor in deciding the success or failure of retail business [6]. Furthermore, the rate of new product/service failure is alarming, which necessitates that service providers study consumer resistance at the retail level and other influencing factors associated with it. Not only in consumer retail but even in the IT sector, user resistance is considered as a significant problem. But there is a dearth of empirical studies in the area of retail consumer resistance to adopt MPSs.

Consumer resistance affects not only the adoption rate but also the intention to adopt. In a model developed by [7], self-determination theory is framed as an antecedent to IRT theory, and further, it affects the consumer intentions to adopt MPSs. In another research [8], usage, value, risk, tradition, image, and related barriers are significant except for perceived cost barriers toward consumer adoption. The factors of self-efficacy, attitude, norms, and confidence significantly affect the respondents' adoption behavior. In another research study, usage barriers, value barriers, risk barriers, and perceived cost barriers are significant in the adoption of E-Wallet [9]. These results indicate that there is a need for studying the consumer resistance variables related to MPSs.

The growth of smartphones and internet connectivity has transformed financial transactions at the retail level. In the 1990s first mobile wallet was introduced, and today, we have plenty of mobile applications. But the number of research articles related to MPSs has increased only over the last decade. Previous research was conducted to study the variables affecting innovation adoption. The innovation resistance has been neglected by scholars, and only a few empirical research studies are available [10].

The IRT theory is a widely used theoretical framework to study consumer innovation resistance in the literature. Sometimes, researchers create a customized model using the IRT theory and IDT/TPB/Valence theory/TRA to examine consumer resistance.

Earlier studies focused on intentions to adopt, not actual adoption. Again, there is a research gap in understanding post-adoption behavior, such as the recommendations to others and resistance of specific user groups (teenagers and young adults). Further, in resistance studies, one or other form of regression or SEM is used for analysis. [11].

3. Research gap and research question

"Barriers to adoption" is a major research gap in the adoption of innovation research studies. In addition, "degrees of resistance" to adoption is an unexplored area. Again, there is a paucity of "adoption of innovation" research studies focusing on specific groups. Finally, there is a research gap in conducting an experimental study or longitudinal study.

The proposed study "Digital Financial Inclusion: An Experimental Study among Weavers" aims at filling all these major research gaps.

This research study proposed to focus exclusively on "Generation X Weavers." It aims at studying the moderating effect of socioeconomic variables, experience, and personality.

3.1 Research question

To study the inhibitors of digital financial inclusion (barriers of mobile wallet adoption) among weavers and suggest remedial strategies

3.1.1 Research objectives

- To identify the sequence of "barriers of mobile wallet adoption" in terms of most dominant to least dominant
- To identify the sequence of "degrees of resistance" in terms of most dominant to least dominant
- To study the moderating effect of age, education, income, occupation, experience, and personality variables between barrier of adoption and degrees of resistance
- To study the relationship between the variables "barriers of adoption" and "degrees of resistance."
- To study the effect of experimental treatment on the adoption rate
- To study the effect of inertia on the intention to continue among adopters

4. The Conceptual Model

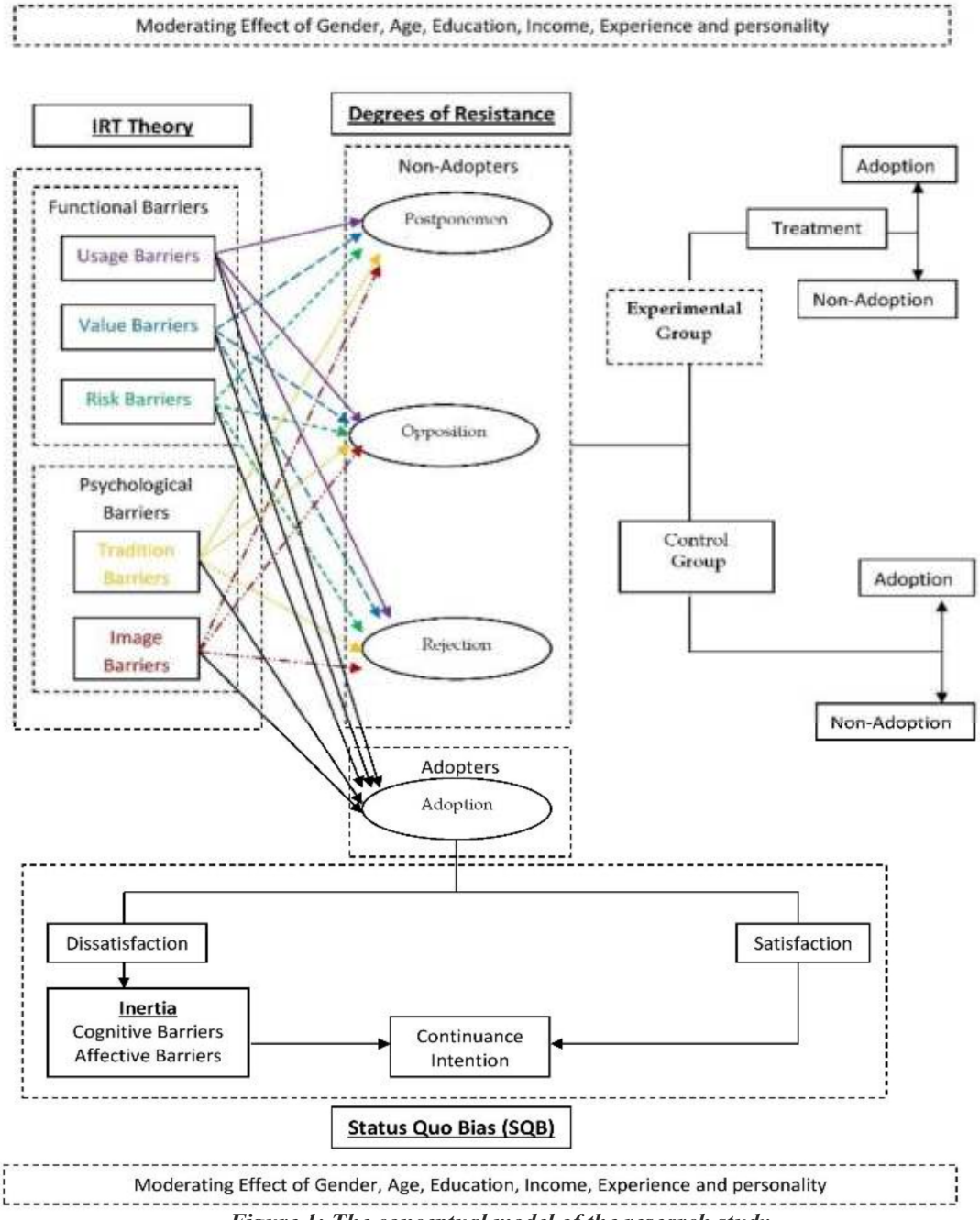

Figure 1: The conceptual model of the research study

The existing research gaps require a holistic model with a multi-dimensional approach, which can be used to study consumer resistance to the adoption of different digital innovations. A conceptual model was developed to bridge the major research gaps. This model can be used to examine the resistance to the adoption of any new products/services based on IRT theory [12] and degrees of resistance [13].

The proposed framework has three phases. The phase one comprises of functional and psychological barriers of IRT theory. Additionally, other relevant barriers based on digital innovations under consideration can be included. The inclusion of new and context-specific barriers is important since the penetration of digital innovation is increasing in trend globally, but consumer adoption is still complex due to confrontations.

The second phase has two groups, namely mobile wallet adopters and non-adopters. The non-adopters are segregated into three different degrees of resistance (rejecters, postponers, and opponents). The consumer resistance can be categorized into any of these three degrees initially. Even the adopters will be included in the resistance study, and their resistance level will be comparatively lower than that of non-adopters. Further inertia among the adopters will be measured. The inertia and intention to continue will be negatively correlated.

In the third phase, the entire sample will be divided into two groups, namely, the experimental group and the control group. The mobile wallet usage will be demonstrated to the experimental group. In addition, the experimental group will get access to a smartphone with internet connectivity and a mobile wallet. The experiment group will be guided by the interviewer to practice the mobile wallet payment using a QR Code (participative product demonstration). On the other hand, the control group will not be given such treatment. After 3 months, the experiment group respondents will be contacted to know whether they have adopted the mobile wallet or not. If they have made a few purchases using a mobile wallet, then it will be considered as adoption. If the consumer resistance changes into adoption, then the participative product demonstration will be considered effective if not it is ineffective. If there is a statistically significant difference between the adoption of the experiment group and the control, then the participative product demonstration is effective [14].

Focus group discussion/open-ended essays are qualitative approaches that help to establish context-specific scales if the researcher is interested in customized scales. Sometimes product/service-specific new barriers can be identified by focus group discussion due to its explorative nature. This model is flexible to engage one or more moderating variables while treating other variables as control variables. For example, if the study is conducted in a country (moderating variable), other socio-economic variables can be treated as control variables. To investigate how personal differences of consumers' impact digital innovations, context-specific moderating variables can be added.

4.1 Hypotheses

H1: The Usage, value, risk, tradition, and image barriers are significantly higher in non-adopters than in adopters

H2: Usage, value, risk, and image barriers are positively correlated with different degrees of resistance

H3: Tradition barriers are not correlated with different degrees of resistance

H4: The impact of usage, value, risk and image barriers with different degrees of resistance is more pronounced (higher) at higher values of age as a moderator

H5: The impact of usage, value, risk and image barriers with different degrees of resistance is less pronounced (lower) at higher values of education as a moderator

H6: The impact of usage, value, risk and image barriers with different degrees of resistance is less pronounced (lower) at higher values of income as a moderator

H7: The impact of usage, value, risk, and image barriers with degrees of resistance is less pronounced (lower) at higher values of experience as a moderator

H8: The impact of usage, value, risk, and image barriers with degrees of resistance is less pronounced (lower) at higher values of openness as a moderator

H9: The impact of usage, value, risk and image barriers with degrees of resistance is more pronounced (higher) at higher values of neuroticism as a moderator

H10: The impact of usage, value, risk and image barriers with degrees of resistance is less pronounced (lower) at higher values of extraversion as a moderator

H11: The impact of usage, value, risk and image barriers with degrees of resistance is more pronounced (higher) at higher values of Conscientiousness as a moderator

H12: The impact of usage, value, risk and image barriers with degrees of resistance is more pronounced (higher) at higher values of agreeableness as a moderator

H13: The adoption rate of the experimental group is significantly higher than that of the control group

H14: The adoption rate of postponers in the experimental group is significantly higher than opponents and rejecters in the experimental group

H15: The adoption rate of opponents in the experimental group is significantly higher than rejecters but lower than postponers

H16: The adoption rate of rejecters in the experimental group is significantly lower than the opponents and postponers

H17: The inertia and the intention to continue among adopters are negatively correlated

5. Conclusion

The proposed experimental study is substantial as it covers the financial inclusion research gap in the existing literature. The study will highlight how to encompass digital financial inclusion among the weavers' community. The result of the study will be useful input for government and other stakeholder to frame policies and promote mobile payment adoption. Thus, the study proposes measures to alleviate poverty among weavers by promoting digital financial inclusion.

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Journal of the TEXTILE Association

WEAVING

Anthropometric Measurement & Assessment of Occupational Ergonomic Risks of Handloom Weaving in Varanasi District

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Abstract

Handloom weaving is one of the oldest surviving traditional crafts in Varanasi and generates a large number of employments. Poor posture is a risk for musculoskeletal problems of the neck, shoulders, and lower back and lengthy hours of static work with awkward posture at traditionally designed looms can lead to a high prevalence of musculoskeletal problems. Keeping in view these facts the present research was planned and a survey was conducted to select four handloom weavers' clusters. The survey was conducted in different handloom clusters of Varanasi. The four selected areas after the survey were selected and Fifty (50) weavers from each cluster were randomly taken for the study. Thus the total sample size was 200. This study was aimed at evaluating the anthropometric measurement of handloom weavers to assess their Body Mass Index to evaluate their physical fitness and Risk Assessment for Musculoskeletal Disorder by Rapid Entire Body Assessment (REBA).The 5th, 50th, and 95th percentile of the various recorded anthropometric dimensions of the handloom weavers were also evaluated. The observations regarding the above anthropometric measurements can be used for redesigning the traditional handloom which will minimize the musculoskeletal disorders of the weavers. The working postures of the handloom weavers during weaving were observed and the score was assigned to each body part by using the REBA score sheet. It was observed during the REBA score assessment that sitting with slight forward bending flexion at the neck and the back with the movement of both hands and legs was acquired by the majority of the handloom weavers while performing the weaving activity.

Keywords: *Environmental factors, Ergonomics, Handloom weavers, Health problems, musculoskeletal problems, Socio-economic conditions*

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1. Introduction

The ergonomic approach of evaluating the present handloom employment status and ergonomic intervention will help in finding some effective solutions. The financial misfortune due to such disorders influences not only the individual but moreover to society also. It is necessary to assess & control occupational health hazards at the workplace of weavers which may cause injury, illness, weakened health, discomfort, and inefficiency in workers of the community. Because of incompatible working circumstances, handloom weavers in textile industries are facing challenges with many work-related musculoskeletal issues related to torment and distress. Many ergonomic problems arise from poorly designed tools, work areas, and repetitive motions. The handloom sector is aimed to generate and provides direct and indirect employment to over 4.3 million people all over India [13]. The predominance of the problems are due to poor ergonomics and designing of workstation and prolonged hours of constant working atmosphere in the carpet industry [2].

The research will focus on how occupational health hazards at the worksite affect handloom weavers and based on findings future recommendations for the corrective measure can be proposed. As occupational health is affordable, accessible, follows equity and contributes to the national economy, the finding of research will help in strategy formulations for handloom weavers; thus the handloom weavers' society can be benefited.

The findings explored through research will be applied for making weavers compatible systems, strengthening the application of high-quality ergonomics, strengthening the demands for high-quality ergonomics by enhancing awareness. Handloom weavers do physical labor beyond their capacity. Hence, Ergonomic interventions will be made in the study regarding the multifactorial genesis of work-related muscular disorders, health problems, and physical conditions of the workplace for sustainable employability to prolong working life. Ergonomics points to ensure that tasks, tools and equipment, facts, figures, content and information, and the conditions and circumstances suit each worker.

The textile and apparel industry is one of the foremost driving sections in the Indian economy. Ergonomics is the scientific and logical application of the standards and strategies that can draw data from several disciplines for the advancement of the system in which an individual plays a significant role. In the garment industry, numerous operations are repetitive in nature and continuous repetition of the work causes musculoskeletal problems and disorders. It has been broadly recognized that awkward and constrained postures result in musculoskeletal disorder on distinctive body locales of seated workers and are a significant component in the emergence of the development of

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musculoskeletal disorders. Destitute postures have also been found to be related to diminished effectiveness of performance, which is caused by body discomfort resulting from confined and restricted body postures.

Musculoskeletal disorder related to work is a major problem in most occupations. The prevalence, characteristics, and impacts of WMSDs in certain anatomical areas of the body among handloom industry workers in Kerala was determined.. This research was conducted with a modified Nordic Musculoskeletal Questionnaire (NMQ) to assess the prevalence of disorders that occurred. A self-administered questionnaire in regional language was prepared and distributed among 380 full-time handloom workers [19]. The research was conducted to study the dietary status, socio-economic status, and occupational health hazards of the Baluchari Saree weavers of Bishnupur. Sixty-two handloom weavers in the age group between 17-75 years willingly co-operated for the study and thus were selected by the convenient sampling procedure. The evaluation of their nutritional condition exhibited notable pervasiveness of malnutrition (53.22 %) in the weavers of Baluchari Sari [11].

A total of 60 workers were taken for the study from the Lakhimpur district of Assam. The assessment of the working posture of women workers involved in various handloom activities was performed. Data were collected by interview method, photography, video recording, and observation of work practices. The postural assessment was done by using ergonomic tools: RULA and Strain Index. Awkward postures were observed in the handloom workers. The mean RULA score was found highest in weaving activity with 6. 41±0.49 followed by warping, spinning. Strain Index was found highest in the right hand and left hand of weaving activity. The high occupational risk was found in the handloom activities. Therefore, the application of ergonomics would help in reducing postural exertion [4]. The lengthy hours of constant work with inappropriate posture at old designed looms causes the extreme presence of musculoskeletal disorders among carpet weavers. The backrest minimizes some of the trunk or torso loads and assists in impeding vertebral strain. The distinctive sitting postures acquired by the handloom weavers while performing weaving tasks are upright, forward flexed, and side bending. Extended flexion of the spine leads to expansion of intervertebral joint laxity and loss of fluid in the intervertebral discs [5, 8].

Forty women weavers of Samarinda sarongs were investigated to ascertain the widespread and risk component of musculoskeletal disorders (MSDs). In this study, a Nordic body map, anthropometric equipment, and rapid upper limb assessment (RULA) were used to intrigue the MSD extremity, work posture, and anthropometric dimensions of the weavers, respectively [16]. In the present era of advancement and commercialization, the handloom sector is also indicating the changes that the large numbers of women are adopting the weaving activity as their profession. The activity they performed previously during their spare time, has now been transformed to an eight hour job. But, in spite of the increased weaving time spent on weaving looms, the workstation design remains unaltered [16].

In traditional old looms, normally there is no workstation adjustability and adjustment of weaving height is difficult that causes the awkward postures of the upper body. Inappropriately designed hand tools and the kind of the task are the chief causes of awkward postures of wrists and fingers [6]. Handloom is one of the long-established cottage industries in India, especially in West Bengal, where a significant number of rural people are engaged in weaving. The outcome of the present investigation revealed that highly repetitive works carried out for a long time could increase the intensity of the pain felt and would lead to repetitive strain injuries [3, 9].

The Finnish Institute of Occupational Health (FIOH) identified musculoskeletal disorders as one of the most widespread work-related frailty, emphasizing that despite several parts of the body being involved, the back experiences most of the discomfort [12, 15]. The postures of workers also need to be modified, and corrective measures need to be introduced to minimize the risk of musculoskeletal disorders in the long term [18]. The weaver has often been forced to adopt squatting posture to operate the traditional carpet looms and as the width of the carpet increases and they have to lean forward to complete the task [3].

2. Methodology

2.1 Selection of Sample

The survey was conducted in different handloom clusters i.e. Madanpura, Badi bazaar, Alaipura, Nati Imli, Lallapura, Ramnagar, Lohta, Baragaon, Basani, Ashapur, Bajardiha, Ausanganj, Golgada, Basani, and Saraiya. The four selected areas after the survey were Lallapura, Bajardiha, Ausnganj and Saraiya. Fifty weavers from each cluster were randomly taken for the study. Thus the total sample size was 200.

2.2 Development of the tool

The socio-economic questionnaire was administered to the weavers for the evaluation of their socio-economic status. A thorough investigation of the review of literature helped and enabled the researcher to develop the tool. Care was taken to incorporate all the needed information as decided and a suitable interview schedule was prepared to get relevant information based on the interview.

2.3 Collection of Anthropometric Data

Various anthropometric measurements of handloom weavers such as sitting height, sitting eye height, sitting shoulder height, sitting elbow height, sitting mid-shoulder height, waist height, popliteal height, buttock popliteal height, shoulder breadth, hip breadth, arm reach forward, elbow to elbow, upper limb length, forearm hand length were taken. All subjects were told to wear light clothing without footwear. For taking standing measurements, the subjects were informed and asked to stand upright and facing forward

and arms hanging adjacent to the body. To take measurements in sitting position, subjects were asked to sit upright on a chair without the support of armrests, with knees bent on 90 degrees, and the feet kept flat on the surface, facing forward and arms hanging adjacent to the body. The measurements of each handloom weaver were taken three times for maintaining the accuracy in results. The analysis of the data obtained in the present study was done precisely. The 5th, 50th, and 95th percentile values were also calculated to understand and interpret the data. The statistical analysis of each group of data was conducted for the elucidation of the results.

2.4 Risk Assessment for Musculo-skeletal Disorder by Rapid Entire Body Assessment (REBA)

REBA is an ergonomic tool for the assessment of musculoskeletal disorders which uses a structured and organized procedure to assess the whole body postural MSD and risks related to the performance of the tasks. REBA is a single-page worksheet that is used to assess the required or selected body posture, intense and forceful exertions, type of movement, motions, and action, reiteration, and coupling of the body parts during the performance of an activity or task.

Posture for risk of work-related musculoskeletal disorder among handloom weavers in Varanasi was assessed by using REBA Scale [14].

Table 1 - REBA Decision Score

REBA Score	Risk Level
1	Negligible
2-3	Low
4-7	Medium
8-10	High
11-15	Very high

3. Results and Discussion

3.1 Risk Assessment for Musculo-skeletal Disorder by Rapid Entire Body Assessment (REBA)

The working postures of the handloom weavers during weaving were observed and the score was assigned to each body part by using the REBA score sheet. The position of the wrist, neck, lower arm, upper arm, and trunk during the handloom weaving activities was also critically observed for analysis of the posture.

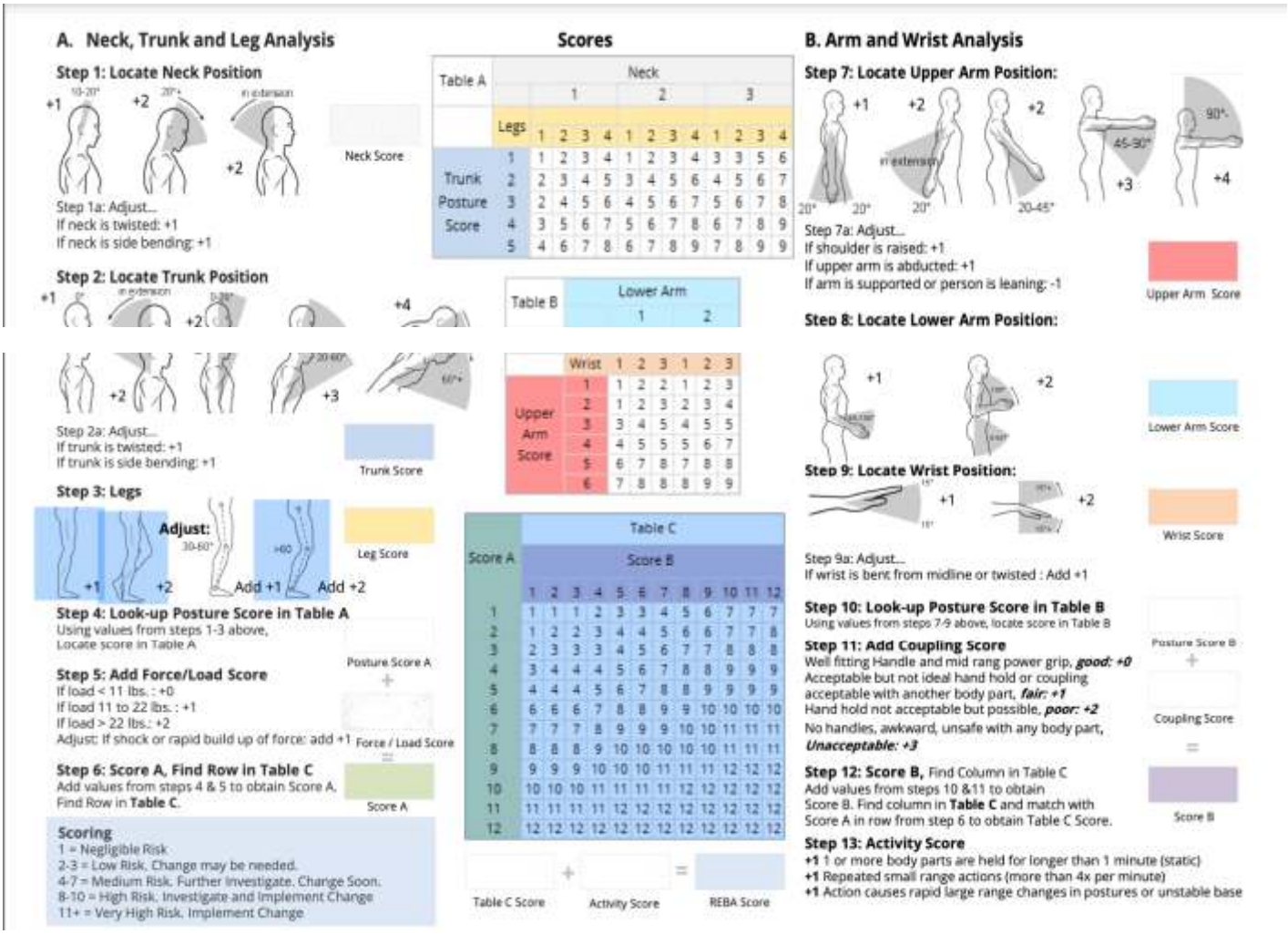

Table 2 - Employee Assessment Worksheet

Body parts	Mean	Standard deviation	Maximum score
Neck	2.60	0.3648	3
Trunk	4.80	0.3678	5
Upper arm	3.40	0.4356	6
Lower arm	1.00	0.0000	2
Wrist	2.00	0.0000	2
Coupling	2.00	0.0000	2
Score B	7.8	0.3657	12
Score C	9.8	0.4323	9
Activity score	1.00	0.0000	1
REBA score	10.8	0.4566	11

Table 2 reveals the REBA score assigned to different body parts of handloom weavers in Varanasi handloom clusters. It showed that in the score a maximum mean score of 4.80 was for the trunk and in the score, B maximum mean score of 3.40 was for the upper arm. The mean for score B which included wrist, lower arm, upper arm, and coupling was higher (mean score 7.80) when compared to score A (mean score 6.74) which included neck, trunk, leg, and force /load score. The mean for score C was 9.80 which after adding the mean of activity score (mean score 1.00) turned to REBA mean score (mean score 10.6.). It was observed during the REBA score assessment that sitting with slight forward bending flexion at the neck and the back with the movement of both hands and legs was acquired by the majority of the handloom weavers while performing the weaving activity.

Postures with elbow flexion of the right hand, abduction, and adduction of the hands, flexion of wrist and pronation of the legs and feet during treadling operations, pronation of hands during beating action and passing shuttle, raised shoulder abduction, and shoulder flexion while weaving were found among the handloom weavers. These all significantly contributed to the musculoskeletal disorders and health hazards of weavers.

A study was conducted to assess the risk of musculoskeletal disorder in handloom weavers of the Durrie unit. The data in their study revealed that the mean REBA score was 11 which indicated a very high level of risk and the mean QEC score for neck, back, and wrist/hand was 17, 31, and 43 respectively were in the very high-risk category and shoulder/arm with mean score 37 in the high-risk category. REBA reported 56.25 percent of weavers were at elevated risk level and 43.75 percent at extremely elevated risk level. QEC also reports 61.25 percent weavers at high and 38.75 percent at the very high-risk category [20].

Table 3: Percentage-wise distribution of the handloom weavers based on REBA score (N = 200)

Action Category	Interpretation	REBA Score (Frequency)	REBA Score (Percentage)
1- Negligible	No change is required	-	-
2-3- Low risk	Change may be needed	-	-
4-7- Medium risk	Further investigation and changes needed	28	14
8-10- High risk	Investigation and implementation of changes	95	47.5
11- Very high risk	Implementation of changes	77	38.5

The REBA action category presented in Table 3 reveals that a maximum of 47.5 percent of weavers was in action category 4 which ranged between score 8-10 i.e. high risk which signifies directions for investigation and implementation of changes wherever needed, whereas, 38.5 percent of handloom weavers were in action category 5. The score of action category 5 is above 11 i.e. very high risks and this signifies directions to implement change immediately. 28 percent of handloom weavers were found to be in action category 3 which ranged between 4 - 7 i.e medium risk and required further investigation and needed changes.

3.2 Anthropometric measurements of handloom weavers

Various anthropometric measurements of handloom weavers were taken for ergonomic interventions. The observations were analyzed and mean, standard deviation was calculated. The 5th, 50th, and 95th percentile of the various recorded anthropometric dimensions of the handloom weavers was also evaluated.

The mean sitting height and sitting eye height were 82.13 and 68.43 respectively, whereas the 5th percentile of sitting height and sitting eye height was 73.00 and 61.23 respectively. The mean sitting shoulder height and sitting mid-shoulder height were 51.64 and 39.12 respectively. The mean popliteal height was 46.85 whereas the mean buttock popliteal height was found to be 54.38. The mean hip breadth, elbow to elbow, forearm hand length, waist breadth, and upper limb length were 33.53, 36.34, 34.78, 33.16, and 34.73 respectively. The observations regarding the above anthropometric measurements can be used for redesigning the traditional handloom which will minimize the musculoskeletal disorders of the weavers.

Table 4 - Anthropometric measurements of handloom weavers in Varanasi District

	Mean	Standard deviation	5th percentile	50th percentile	95th percentile
Sitting height	82.13	3.52	73.00	84.31	88.45
Sitting eye height	68.43	2.98	61.23	72.44	76.90
Sitting shoulder height	51.64	3.76	48.32	55.12	59.89
Sitting mid-shoulder height	39.12	4.12	29.00	42.54	46.97
Sitting elbow height	32.34	3.94	26.12	35.89	38.00
Popliteal height	46.85	4.24	36.89	48.66	56.66
Waist height	24.54	2.25	21.21	25.65	29.90
Shoulder breadth	22.57	3.87	18.00	22.44	26.88
Buttock popliteal height	54.38	3.26	49.54	55.43	63.33
Hip breadth	33.53	4.34	31.00	35.00	43.79
Elbow to elbow	36.34	4.12	30.76	37.54	44.00
Forearm hand length	34.78	2.65	32.00	36.67	38.88
Waist breadth	33.16	3.96	25.43	29.90	38.44
Upper limb length	34.73	2.27	64.56	73.00	75.55

The mean sitting height and sitting eye height were 82.13 and 68.43 respectively, whereas the 5th percentile of sitting height and sitting eye height was 73.00 and 61.23 respectively. The mean sitting shoulder height and sitting mid-shoulder height were 51.64 and 39.12 respectively. The mean popliteal height was 46.85 whereas the mean buttock popliteal height was found to be 54.38. The mean hip breadth, elbow to elbow, forearm hand length, waist breadth, and upper limb length were 33.53, 36.34, 34.78, 33.16, and 34.73 respectively. The observations regarding the above anthropometric measurements can be used for redesigning the traditional handloom which will minimize the musculoskeletal disorders of the weavers.

4. Conclusion

The hand-woven textiles of India have been recognized and mentioned since ancient times and it is deeply rooted in our lives and traditions. In spite of the fact that it provides and creates employment opportunities for a large number of people, the handloom segment is contemplating as a dusk industry, and there are unavoidable circumstances and discuss of certainty which has given the continual stepping towards the motorization, advancement, and refinement. Still, there are many supporters of handloom for reasons including their logical justifications, beliefs, ethics and principles, sheer affection for handloom products, and economic viewpoint. Many policies and programs were prepared by the government to increase the production, productivity, and GDP through this sector but no attention has been paid to the human component of this sector. Workers, an integral part of this sector, suffer from many health-related hazards due to the nature of this work. Handloom weaving requires long hours of work in static and awkward posture which gradually leads to the risk of work-related musculoskeletal disorder. It has been broadly accepted that inappropriate and severely restricted postures result in musculoskeletal pressure on various body parts of workers in sitting positions and it is the crucial component in the evolution and growth of musculoskeletal problems. Poor postures have also been closely linked with diminished productivity of execution, which is predominantly caused by bodily discomfort which occurs due to limited and restricted postures.

Based on the subjective assessment and responses obtained from the handloom weavers, the major concerning criteria found were related to the following:

- Designing of plank, adjustable height of the seat, depth of the seat and the forward slope/inclination at a different angle and the width of the plank, and the requirement of the backrest.
- The different adjustable seat heights can be prescribed and made based on the data obtained of the popliteal height of the handloom weavers. There should also be an adjustable backrest at the time of weaving as well as at the time of rest during weaving.
- The slope angle of the seat should be adjustable according to the need of the handloom weaver.
- The seat depth should also be modified according to the anthropometric measurements.
- An ergonomically equipped workstation for the weaving allied activities would also be helpful in reducing the exertions which are found during different handloom weaving-related activities.

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Design & Development of Sustainable Embellished Fashion Ensembles For Alpha Women

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Abstract

The recent years have witnessed an upsurge for funky and quirky yet affordable and eco-friendly fashion ensembles among millennials and generation Z.

Accordingly, designers are in the quest of coming up with design collection that are affordable, sustainable and appealing to the common masses. There is an ardent need of switching over to sustainable principles and approaches to avert the deleterious environmental impact posed by conventional textile and fashion supply chain. The sustainability can be incorporated at various phases of supply chain such as raw material procurement, adoption of eco-friendly manufacturing, transportation and packaging options. Furthermore, usage, care and disposal of end products by consumers also strongly influence the fate of garments during the end of their useful life. Many high end brands are prioritizing sustainable principles and catering to demands of consumers by transition from conventional raw materials and dyestuff procurement, surface ornamentation, usage of trims and embellishments, labeling and packaging to eco-friendly options. Accordingly, the usage of sustainable and recycled fibres, organic dyes, sustainable substitutes for animal based leather like corn and mushroom leather and sustainable manufacturing and ornamentation techniques like 3D printing, sublimation printing and digital printings are revolutionizing the fashion arena and are considered to be commendable steps towards environmental and social well-being. The latest ornamentation techniques are not only eco-friendly unlike age old traditional dyeing and printing techniques involving the utilization of hazardous and toxic chemicals dye stuff, auxiliaries etc but also offer an array of motif and color way for the designers to explore and experiment with myriad of design elements.

The present study was undertaken with an intent to design and develop sustainable, funky fashion ensembles for millennials utilizing recycled polyester and eco-friendly embellishment technique namely sublimation printing.

The market survey and unstructured interviews with teenagers and professional alpha females enabled identification of street fashion trending among millennials. An array of vibrant, quirky and funky motifs aiming alpha women who embrace cotemporary and fusion styles were created for development of virtual and physical garment and accessory prototypes.The designed ensembles were subjectively evaluated in terms of their functional attributes, comfort, aesthetic appreciation and sustainable concepts by respondents chosen for the study.

Keywords: *Accessories, Alpha, Apparels, Embellishment, Funky, Printing, Quirky, Sublimation, Sustainable.*

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1. Introduction

The fashion industry has witnessed a major transformation as far as raw material selection, manufacturing processes, packaging, labelling and transportation of end products is concerned owing to sustainable aspirations of stakeholders at various stages of fashion supply chain. Accordingly, the apparel and accessory manufacturers along with associated embellishment job providers ensure that all the processes are carried out following sustainable routes [1]. In view of that, innovative and sustainable techniques like sublimation printing, digital and 3D printing are revolutionizing the fashion arena. Heat transfer, also referred to as thermal printing or thermal-transfer printing is a user friendly and sustainable printing technique involving transfer of digitally created motif or art work on sublimation paper to textile substrate or garment via specially designed heat transfer printing machines [2, 3]. Aesthetic appreciation and value addition is plausible for a myriad of apparel and accessory styles employing aforesaid ornamentation techniques. The present study has been undertaken to design and develop sustainable, funky fashion ensembles for millennials utilizing recycled polyester and eco-friendly embellishment technique namely sublimation printing and assessment of commercial viability of the design collection thereof by subjective evaluation in terms of their functional attributes, comfort, aesthetic appreciation and sustainable concepts by respondents chosen for the study.

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2. Materials & methods

a. Materials

A range of raw materials, trims and notions were procured for the study. Canvas fabric was procured online while 100% recycled polyester fabric was procured from local factory in NCR. Trims, notions and sublimation paper were procured from local market. The procured canvas and recycled polyester fabrics were used to stitch tote bags and t shirts in house.

b. Methods

The procured raw materials were tested for their physical properties namely aerial density, fabric thickness and fabric cover. The motifs, mood board and story board were prepared using adobe illustrator and Photoshop. Heat transfer method was used to transfer the printed motifs on sublimation paper onto textile substrate. The prepared motif was printed on a special release paper using toner. The printed image was placed on textile substrate and pressed under high temperature for time duration ranging from 60-180 seconds. The release paper was peeled away as the motif was transferred to the substrate. The detailed workflow for design and development of fashion ensembles is presented in Table 1. Various textile substrates of varying fibre composition were sublimation printed to achieve the best results in terms of motif clarity, sharp edges and vibrancy of colors. The trials are being shown in Table 2.

3. Design & development process

The unstructured interviews and market surveys assisted in the design process via selection of motifs, color ways and trends in streetwear. Consequently, mood board, story board and motif to narrate the theme of design collection were developed. Thereafter, the designed motifs were transferred on the sublimation paper. The t shirts were stitched using recycled polyester fabric in-house utilizing single needle lock stitch machine and serger machine. The exact location of motif placement on t shirt was identified and the sublimation paper with printed motif was then placed on the desired position to be finally placed on the bed of transfer printing machine. Likewise, the printed motifs selected for laptop sleeves and tote bags were first transferred through sublimation paper on fabrics to be later converted into totes and laptop sleeves. Figures 1 shows the motifs for the design collection. Figure 2 shows the physical prototypes developed utilizing the sublimation printing.

Table 1 - Workflow for design and development of fashion ensembles

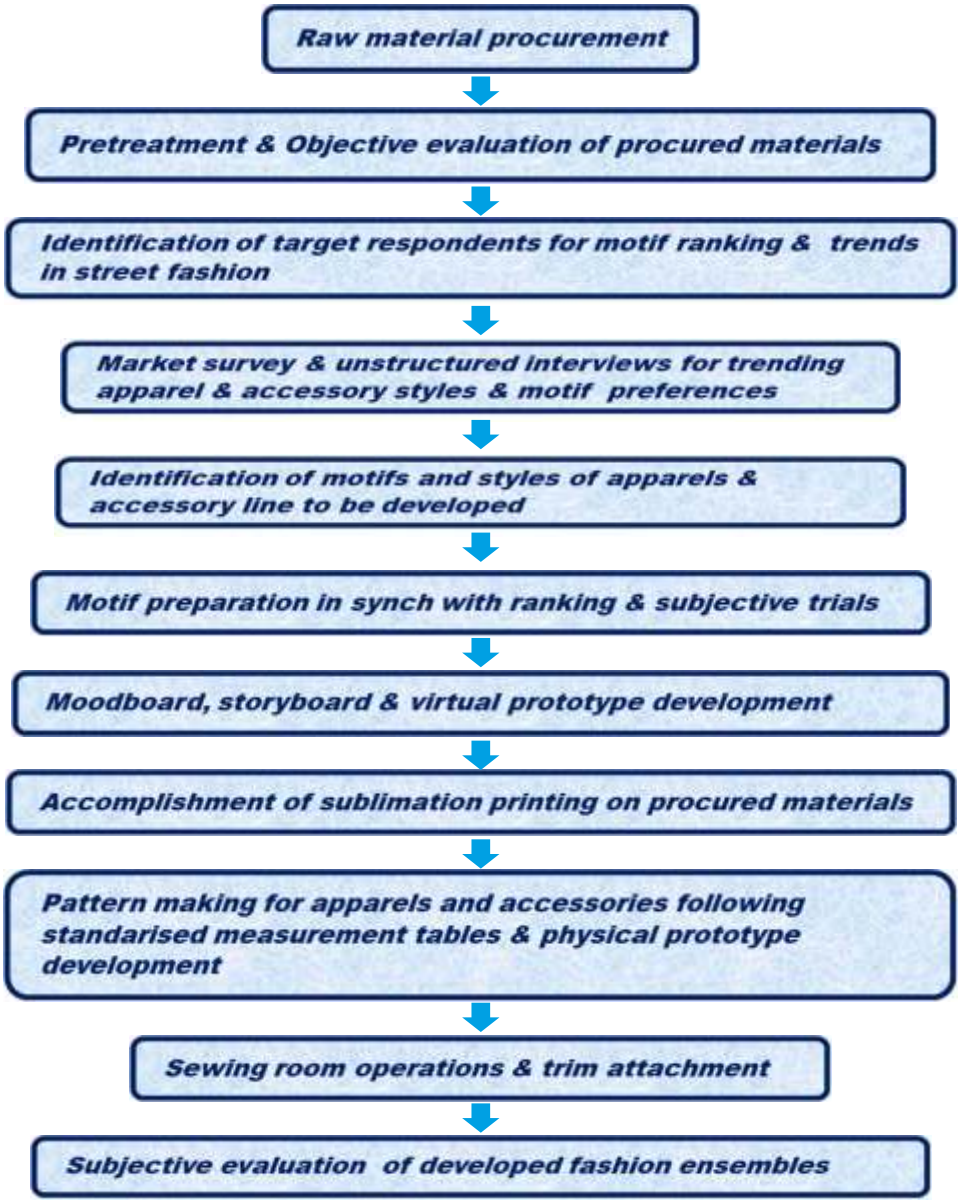

Table 2- Sublimation Printing Trials on various textile substrates

Sr. no.	Fabric construction	Duration (min)	Temperature	Impression	Visual examination of motif
1.	Twill woven 60: 40 PET/C blend	2	200	moderate (fabric burn)	
2.	Twill woven 50:50 PET/C blend	2	200	Light	
3.	Twill Woven 30:70 PET/C blend	2	200	very light	
4.	Twill woven 100% Cotton	2	200	Negligible	
5.	Twill woven 100% PET	1	100	Prominent	

Figure 1 – Motifs created for design collection

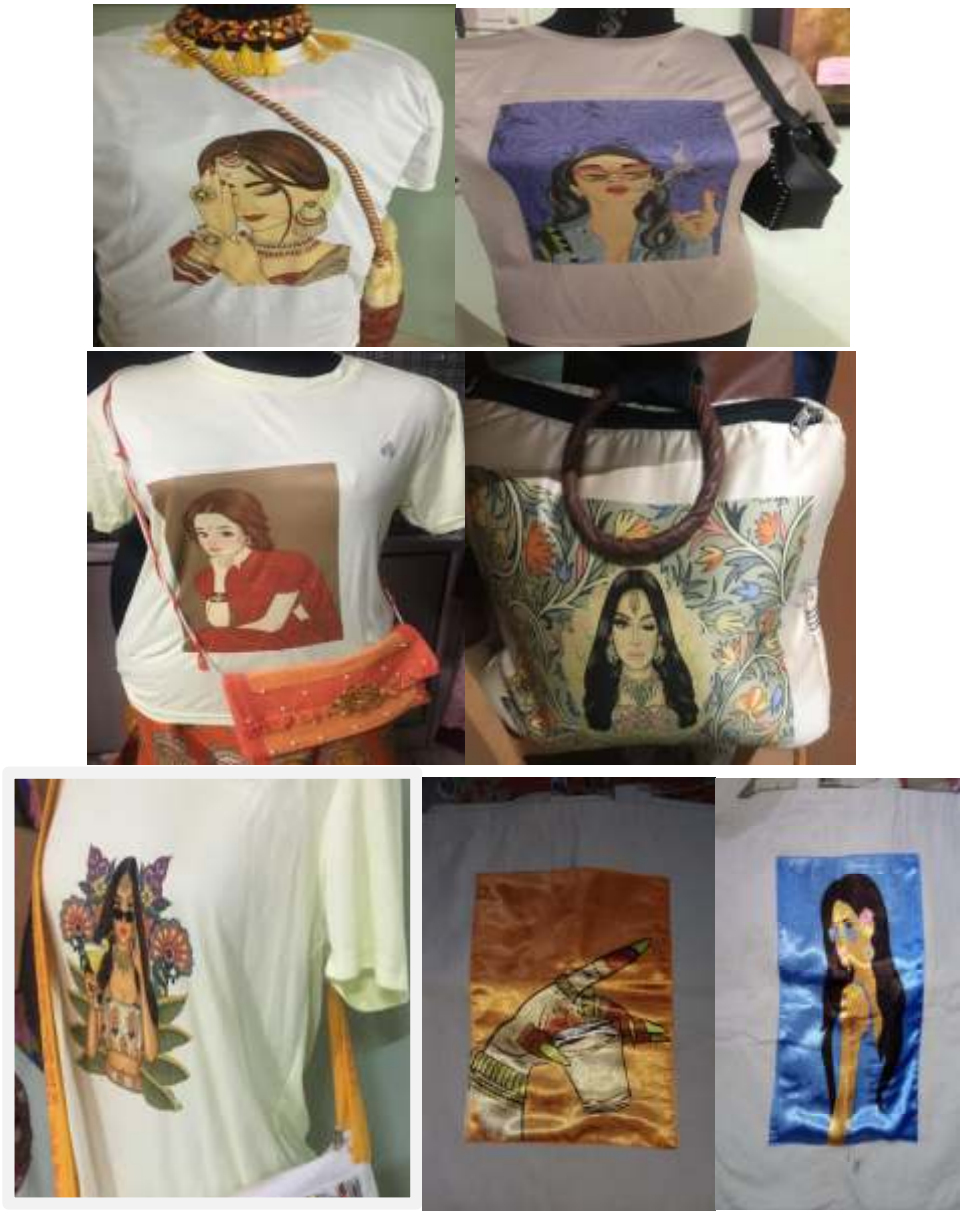

Figure 2 – Physical prototypes developed using Sublimation printing

4. Results & Discussion

A range of motifs were shown to subject to rank as per their liking. The most preferred motifs were those narrating the story of alpha women, balancing their persona with wit and charm. Consequently; a design collection "Chic vis a vis Alpha" comprising embellished T-Shirt, laptop sleeve and tote bag was developed to be subsequently evaluated subjectively by respondents. The results of subjective evaluation suggested that subjects liked the design collection and found it quite affordable. Sublimation printed laptop sleeve was the most likeable and utilitarian accessories as per the subject.

The subjective evaluation and market survey by subjects aged 18-30 years assisted in finalizing the garment and hand bag styles along with motif to be printed on the fashion ensembles. Crew neck and polo T-shirts were preferred by the subjects while as far as handbag styles were concerned; they preferred an embellished laptop sleeve and tote bag for easy donning & doffing during mundane activities. 54% respondents preferred printing as the most appealing embellishment techniques for their apparels and accessories in contrast to 20% & 17% who preferred dyeing and embroidery respectively as the most likeable embellishment technique. 54% respondents preferred funky motifs for laptop sleeve in contrast to traditional and caricature motifs. 66% respondents preferred funky prints for tote bags while 29% respondents preferred traditional motifs to be printed on their tote bags. Respondents found the designed ensembles affordable and were keen to buy laptop sleeve in price range of Rs 500-800. Almost all the respondents found the design collection relatable, likeable and affordable with t shirts and laptop sleeves the most preferred among fashion ensembles.

5. Conclusion

The worldwide clamor for eco-friendly and sustainable practices in textile supply chain necessitates switching over to innovative technique of garment manufacturing and their embellishment. Sublimation printing is a promising and eco-friendly avenue that eliminates the requirement of toxic dyestuff and auxiliaries used in traditional printing technique.

The present study was undertaken with an intent to design and develop sustainable, funky fashion ensembles for millennials utilizing recycled polyester and eco-friendly embellishment technique namely sublimation printing. The market survey and unstructured interviews with teenagers and professional alpha females enabled identification of street fashion trending among millennials. An array of vibrant, quirky and funky motifs aiming alpha women who embrace cotemporary and fusion styles were created for development of virtual and physical garment and accessory prototypes. A design collection " Chic vis a vis Alpha" was developed and evaluated subjectively by subjects aged 18 - 25 years. The designed ensembles were subjectively evaluated in terms of their functional attributes, comfort, aesthetic appreciation and sustainable concepts by respondents chosen for the study. Result of subjective evaluation suggested that design collection was likeable among the subjects. They were appreciative of the motif selection which portrayed Alpha Women. Embellished laptop sleeves were the highest rated functional as well as aesthetic accessories by the respondent.

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Journal of the TEXTILE Association

Investigation on Mechanical and Morphological Characteristics of Ramie/Silk with Epoxy Hybrid Composite of Filler OMMT Nanoclay

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Abstract

Light weight is an important requirement in design today to save energy. Reduction in the weight of a vehicle can lead to improved fuel economy. Components made of lightweight materials may be subject to static and dynamic loads in operation, and hence the materials used should have adequate stiffness and strength. For the selection of a suitable material in a design, its mechanical characterization should be carried out to know its behavior. The present work is aimed at incorporating silk and ramie fabrics with the epoxy matrix and studying the effect of montmorillonite nanoclay (OMMT) on the silk and ramie hybrid composites. Five different laminates were prepared using the manual hand layup method with a filler percentage of 3%. The prepared laminates are cut according to the ASTM standard for conducting different mechanical tests. The result shows that the incorporation of pure ramie fibres enhances the mechanical characterization. The hybrid composite of laminate RSSR with 3% OMMT nanoclay produced the highest tensile strength compared to the other two hybrid laminates. The highest flexural strength and modulus are found in the laminate RRRR. The moisture absorption percentage was maximum for ramie laminate RRRR and minimum for silk laminate SSSS. The fractured tensile specimen was analysed by SEM.

Keywords: *Ramie, Silk, Epoxy, OMMT Nanoclay, Mechanical properties, and SEM*

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1. Introduction

Natural fibres like banana, jute, sisal, hemp, etc. can be used as substitutes for synthetic fibers. To name a few of them, glass, carbon, boron, and Kevlar are the conventional fibers, and these fibres are not biodegradable and have a higher cost. in the case of natural fibres due to their advantages such as lower cost, lighter weight, ease of processing, and biodegradability. In regard to the several publications relating to natural fibre hybrid composites, the mechanical properties have been studied. It was found that better mechanical strength is obtained for the hybrid composites than the conventional natural fibre composites [1, 2]. Natural fibres are increasingly being used due to their biodegradability, abundance, affordability, and low processing energy requirements [3, 4]. In polymer composites, natural fibres are used as reinforcement, and they are plant, animal, and mineral fibres to the matrices such as thermoset and thermoplastics, due to their exceptional qualities, including high specific modulus, great resistance to wear and tear, and lightweight [5, 6]. This analysis focuses mainly on natural fibres made from plants because the research community and business have recently turned their attention to this source of fibre. However, in order to give readers a comprehensive understanding of natural fibre reinforced polymer composites, bagasse, sugar palm, bamboo, wood, pineapple, hemp, cotton, jute, and kenaf fibres have been widely employed in various polymers to improve the characteristics of the composites, especially from the standpoints of the environment and biodegradability [7, 8]. Due to the variation in the diameter, length and their specific gravity, the mechanical and physical properties vary in the fibres more importantly. However, the fibres can be compared only to their chemical constituents only [9]. Although natural fibres have been thoroughly investigated as polymer reinforcing materials, numerous other natural fibres, including those from banana, abaca, ramie, and pine, have comparable chemical compositions and have not yet been thoroughly investigated [7]. The lack of research on these fibres as reinforcing agents for composites shows that there is opportunity for additional investigation in the sector and that there are endless opportunities to advance this technology. In order to improve

the composite qualities, hybrid composites are created by employing multiple reinforcing agents in the same polymer matrix. When numerous reinforcing materials are combined, it is possible to achieve either a material's synergistic or antagonistic effects [10].

Compared to single-fiber reinforced composites, the integration of numerous reinforcements in a matrix gives a wider range of properties. As a result, the scientific community has given the combination of reinforcing agents with natural and synthetic origins a great deal of attention [11]. Because synthetic fibre composites' properties are regarded to be better than those of natural fibre, their usage in the manufacturing and production sectors is unavoidable [12]. The natural protein fibre that has been found to be the best for biodegradability and biocompatibility is silk, which is frequently utilised for implantable purposes. The silk properties include strong strength (650-750 MPa), high elastic modulus (16GPa), density (1.3-1.38 g/cm3),

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elongation at break (18%-20%), and excellent resilience [13]. Due to their substantial crystallinity and strong hydrogen bonding, silk fibres have improved environmental stability [14]. The silk fibres are made up of two proteins: fibroin and sericin. In contrast, sericin was taken out of silk by using an implanted application during the degumming process. A fibrous substance called silk fibroin has an ordered structure and a repeating sequence of amino acids that are high in alanine and glycine [15, 16]. Particularly helpful in biomedical applications are tissue engineering, wound treatment, and implant materials made of silk fibroin [17]. Due to its intriguing qualities, silk was a suitable reinforcement material for composite preparation. The purpose of using natural fibres is to displace synthetic fibres. A type of natural fibre called ramie fibre is obtained from the bark. Additionally, it has the lowest lignin level and the highest cellulose content [18]. As a result, there is enormous strength to be developed as a reinforcement material for composites. Crude ramie fibre has 9.25 % lignin, 9.8-16.7 % hemicellulose, 68.7-70.1% cellulose, 6.95 % moisture content, 1.25 % ash, 0.3-0.6 % waxes, and 4.8 % pentosan as chemical constituents. Ramie fibre is compatible with a variety of substances, making it simple to combine as it has better tensile strength, Young's Modulus, and resistance to biological degradation [19, 20, 21]. However, none of the researchers fully concentrated on natural fibres like ramie and silk fibre reinforced hybrid polymer composites. In this study, the tensile, flexural, moisture absorption, density, impact strength, and hardness characteristics of silk and ramie reinforced hybrid polymer composites are examined to know their behavior.

2. Materials and methods

2.1 Materials

ULTRANANOTECH India Ltd., Bengaluru, supplied the Araldite epoxy resin with the grade name LY556 and the hardener HY-951 for curing the resin, and the OMMT nanoclay of 100 nm. Vruksha Composites Guntur, Andhra Pradesh, India has supplied the woven Silk Fibre and Ramie fibre of 250 GSM.

Table1: Laminate Designation

Sr. No.	Laminates
1	Epoxy
2	S+S+S+S
3	R+R+R+R
4	R+S+R+S
5	S+R+R+S
6	R+S+S+R

R-Ramie fibre, S-Silk fibre

2.2 Ramie Fiber

The natural fibre, ramie, belongs to the Urticaceae family and was hence extracted from Bohemian nivea bast. From the outer section of the stem, usually the fibres will be harvested, which are now being used as textile fabric. The properties of fibers and matrix are represented in Table 2.

Table 2: Physical characteristics of the fibers and epoxy [32]

Table 2: Physical characteristics of the fibers and epoxy [32] Description	Ramie fiber	Silk fiber	Epoxy
Density (g/cc)	1.5	1.38	1.1
Tensile strength (MPa)	1000	650	35 - 135
Tensile modulus (GPa)	61.4 - 128	16	3.4
Elongation (%)	2-4	18-20	1-8.5

2.3 Silk Fiber

Silk fiber is one more fiber that offers properties like low density, flame resistance and high elongation and hence silk fibre portrays higher mechanical performance than plant fiber.

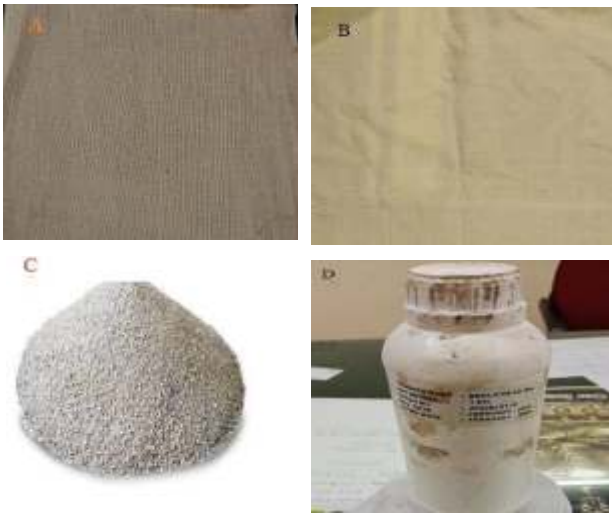

Figure 1 - A. ramie fabric B. silk fabric C. OMMT nano clay and D. epoxy resin

2.4 OMMT nano clay

The nanoclay called montmorillonite is made up of the phyllosilicate group of minerals which, when induced to go suddenly from water solution, form microscopic crystals. The montmorillonite falls under the smectite group. It is a 2:1 nanoclay, which implies that it has the octahedral sheet of alumina put between the two tetrahedral sheets of silica. The median diameter is around 1 μm and the thickness appears to be 9.6 mm. However, the nanoclay particles can be named by utilising the scanning electron microscope with a magnification of about 25,000 times. Saponite is also a member of this group.

2.5 Composite Preparation

The hand layup process was used for developing hybrid

nanocomposites using ramie, silk fibre, and nanoclay are depicted in Figure 1. The nanoclay was dispersed at 3%wt using a sonication process for about 20 minutes at 20 kHz and then mixed with the known quantity of resin. However, the mixture is then poured for composite fabrication. To make the 300x300x3mm3 laminate, 40% of the ramie and silk fibre mixture is manually mixed with the resin. While the process is taking place, all the bubbles which are entrapped are removed by means of a cotton roller. Then, the composite laminates are cured at room temperature for about a day before being put into the oven. Soon after this, the laminates are machined using the water abrasive jet machine as per the requirements of ASTM standards for further testing.

3. Experimental Studies

3.1 Density Test

The density and voids in the laminates are determined experimentally as per the requirements of ASTM D2734-94. The experimental density is calculated by calculating the weight of the specimen by means of air and liquid. The experimental density is calculated using the following equation (1) [22].

$$\rho exp = (wa/wa-wl)* \rho l \quad \text{.....(1)}$$

Where ρexp = experimental density, wa = weight of the specimen in air, wl = weight in liquid, and ρl = liquid density.

For each laminate calculation for the theoretical density will be made for the all trials and values was recorded. Henceforth, the theoretical density will be calculated using the equation (2) [23].

$$\rho th = \frac{100}{\frac{Wm}{\rho m} + \frac{Wf}{\rho f}} \quad \text{.....(2)}$$

Where Wm = the weight fraction% of matrix phase, ρm = the density of the matrix phase, Wf =weight fraction% of fabric, and ρf = the density of the fabric. The voids generally take place during the fabrication process that too, in the manual layup process, which is unavoidable, and can be due to human error. Generally speaking, a composite laminate with less than 5% will be considered good. As the percentage of void increases, the property deteriorates, i.e., the composite cannot be used for commercial use. The tabulated values of the density and void fraction are given in Table 3. The determination of the void in terms of percentage was found using theoretical and experimental densities in Equation (3). [24] And Table 3 shows the experimental and theoretical densities and voids of the specimens.

$$Vp = \frac{\rho th - \rho exp}{\rho th} \quad \text{..... (3)}$$

Where Vp = the void percentage, ρth = the theoretical density and ρexp = the experimental density.

Table 3: Density and void fraction of five laminates

Laminates	Theoretical density ρth (g/cm3)	Experimental density ρexp (g/cm3)	Void (%)
SSSS	1.233	1.226	0.56
RRRR	1.360	1.352	0.58
RSRS	1.266	1.255	0.86
SRRS	1.195	1.184	0.92
RSSR	1.282	1.275	0.54

3.2 Tensile test

The laminate is stacked and weight is added bit by bit until a fracture occurs under tensile loading. By this, the tensile properties of silk-ramie and nanoclay (OMMT) built up polymer hybrid composite will be examined. An electronic information data system is utilized to keep a nonstop record of load versus deflection. Figure 2 shows the composite laminates SSSS, RRRR, RSRS, SRRS, and RSSR displaying the tensile characteristics.

3.3 Flexural test

The flexural strength and modulus will be found as for the dimension of 90 x 10 x 3 mm3, which is as per ASTM D790 in the Universal Testing Machine. Using the flexure test, the three-point bending method will be used with a continuous strain rate of 2 mm/min applied to the five identical samples from each laminate. The application of the load will be on the mid-point of the gauge length, and jaws are used to support the ends of the device. Consequently, the graphs get generated for the breaking load vs. laminates and flexural strain vs. laminates.

3.4 Impact strength

The impact strength will be found out as for the dimension of 63 x 12.7 x 3 mm3, which is as per ASTM D256 using the computerised impact tester machine. The composite laminate was loaded into the impact tester's grippers and the test resulted in the energy absorbed by the laminate after its failure, finally measured in joules.

3.5 Micro- Hardness

The digital Shore-D hardness durometer is used to measure the specimen's hardness. The durometer with a step of 0.5 HD has a range of 0–100 HD and is hence used to find out the hardness of rubber, polymers, as well as plastics. While testing, the durometer is used to press onto the exterior part, where the indenter pin will get penetrated onto the sample, thus displaying digitally the resistance to indentation [27]. Suppose the value of HD is more than 60, it is found that it is a good resilience material or else a poor resilience material.

3.6 Moisture Absorption Test (MAT)

The water absorption test will be carried out by immersing the laminate in normal water as well as in distilled water for

nearly 30 days. However, the laminates were machined enough as per the ASTM D570 standard, for the dimensions of 30×28×3 mm3. The weights of the laminate were frequently measured at intervals of 10 days. The water molecules should be removed from the surface of the specimen using the cotton cloth and weighed with a digital balance. The percentage of moisture absorption was calculated by using Equation (4). [26]

Moisture absorption (%) = Wb-Wa/Wa *100 (4)

Where Wb is the final weight of the laminate after 10 days of immersion and Wa is the initial weight of the laminate before immersion.

3.7 Scanning Electron Microscopy (SEM)

Scanning electron microscopy is a device that will be used for observing the morphology of the composite laminates. This test will be used for analysis of the interfacial properties, internal cracks, and inward design of the broken surfaces of the laminate. The conducting material will be coated on the exterior part of the laminate, preceding the SEM assessment of the surfaces.

4 Results and Discussions

4.1 Density

The void fraction (%) in composite laminates was calculated using the differences in experimental and theoretical densities, which showed some amount of variation (from Table 4). Due to the close compatibility of the fabric, matrix, and filler material, the laminate RSSR had fewer voids (0.54 per cent) than that of other laminates. The void content of laminate SSSS is 0.56 % which is slightly higher than that of laminate RRRR. Furthermore, because RSRS laminate is entirely composed of natural ramie and silk reinforcement, it has a void content of 0.86 percent. The void fractions of all the five different configurations of laminates range from 0% to 1%, which indicates that the composites were properly manufactured and the void percentages obtained are acceptable. It is observed that a higher percentage of filler material showed a lower void fraction, while natural fabrics contained a greater number of voids.

4.2 Tensile test

The tensile properties of laminate designations SSSS, RRRR, RSRS, SRRS, and RSSR were investigated using a UTM machine as per the standards of ASTM. The stress-strain analysis was used to determine the tensile strength and tensile modulus for various laminates. From the figure, it is observed that the composite having only ramie reinforcement (RRRR) has a higher tensile strength of 60.05 MPa and a modulus of 2.74 GPa. It is natural for composites to gain more developed mechanical qualities as the number of layers increases because the load acting on the matrix will be distributed homogeneously. [25] The SSSS laminate consists of only natural silk reinforcement and obtains a tensile strength of 27.69 MPa and a modulus of 3.42 GPa. The hybridised composites of ramie and silk with 3% filler, the designation of laminates RSSR, obtained a strength of 52.37 MPa and a modulus of 2.29 GPa. Figures 2A and 2B represent the different values of tensile strength and tensile modulus of different laminates, respectively. The hybrid laminate of 3% OMMT filled composite has shown a lower tensile strength of 38.14 MPa and a tensile modulus of 4.02 GPa when compared to those of RRRR and RSSR. To move further, the SRRS composite displayed a declined strength value of about 38.14 MPa and 2.29 GPa for the tensile modulus values. So, as per the observations made so far, it can be concluded that the highest tensile and modulus values are exhibited in the case of laminate RRRR, whereas laminates RSSR and RSRS with 3% OMMT filler showed a moderate increase in tensile strength and modulus values. Henceforth, the tensile strength and the tensile modulus values of natural ramie fibre can be improved by the addition of a 3% weight concentration of filler material.

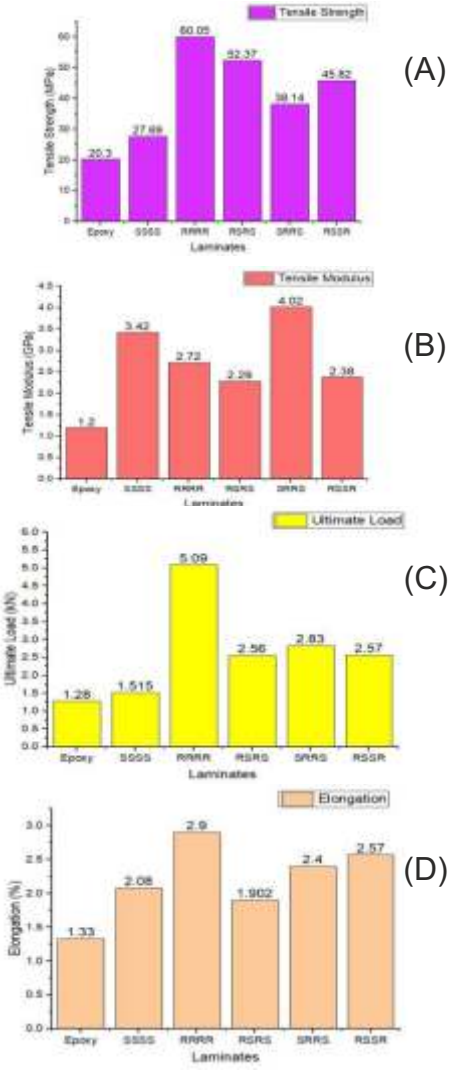

Figure 2: Tensile property of the samples: A. Tensile strength and B. Tensile Modulus C. Ultimate load D. Elongation

4.3 Flexural test

The three point bending method is used to test the flexural properties of the composites for flexural specimens and is thus depicted in Figure 3. The highest flexural load of 203.02N laminate is obtained for RRRR and the least flexural load for SSSS laminates is 61.35 N. When it was hybridised with 3% OMMT to the ramie and silk reinforcement, laminate RSSR displayed the highest flexural load of 101.26 N, compared to the other two laminates of RSRS at 93.77 N and SRRS at 88.09 N. With the increase in filler concentration of 3% OMMT, all the laminates have gained the momentum of strength to withstand higher loads. The characterization for the various laminates for the flexural strength and flexural modulus is shown in Figure 3. The better stress transfer has taken place between the fabric–matrix and the filler material, indicating the better flexural strength. The laminates with 3% of OMMT filler RRRR indicated the highest flexural strength of 116.45 MPa and a modulus of 3.42 GPa when compared to the pure silk laminates SSSS, with a flexural strength of 61.86 MPa and a modulus of 1.874 GPa, respectively. The hybrid laminates of ramie and silk with 3% filler, RSSR, show the highest flexural strength of 92.77 MPa and a modulus of 2.208 GPa. However, when compared to the other two laminates of the same designation, SRRS, it depicted a value of 76.5 MPa and 2.185 GPa, respectively. In view of all these observations, it is concluded that the flexural strength and modulus were elevated by the incorporation of natural ramie fabric.

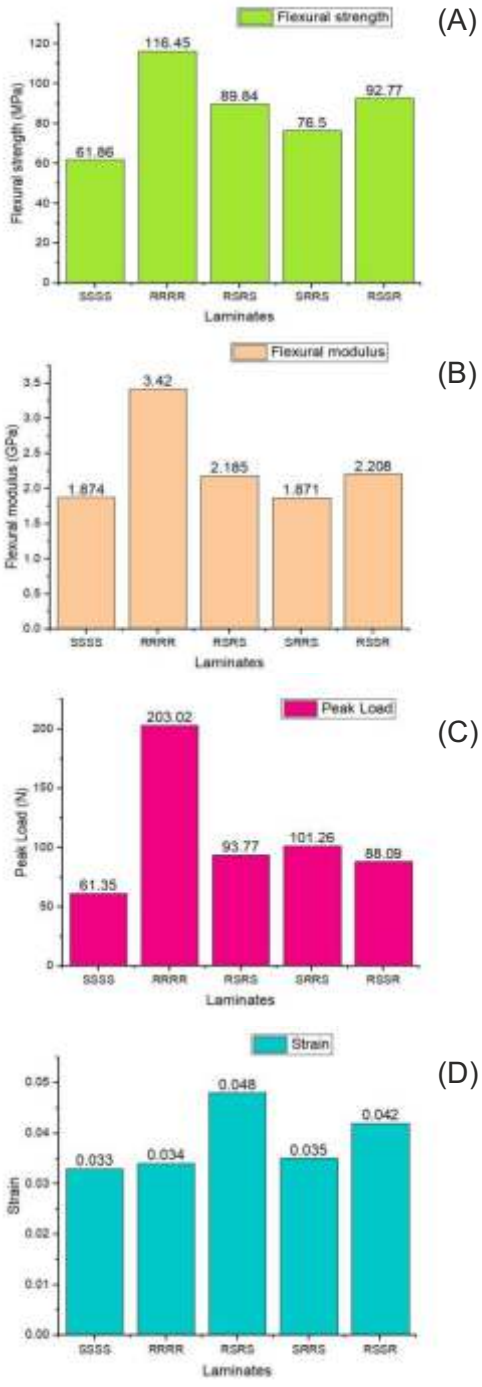

Figure 3: Flexure property of the samples: A. Flexure strength B. Flexure Modulus C. Peak load and D. Strain

4.4 Impact strength

The bonding strength of the fibre and the matrix along with the filler material will be determined by the impact studies. Figure 4 shows the impact strength (kJ/m^2) of the different laminates. The test on the impact relies on many variables, like fibre-matrix bonding and the nature of the fibre material. Equation 6 gives us the calculation of the impact strength. The laminate RRRR with 3% filler has a higher impact strength of 56.58 kJ/m^2 when compared to other laminates. The reason is the stiffness of the Ramie fabric. The pure silk fibre reinforcement laminate SSSS depicts the lower impact strength. This is due to the presence of hemicellulose, which reduced the impact strength. The reasonable impact strength of 36.75 kJ/m^2 was observed in the Silk and Ramie reinforced composite laminates (RSSR). Furthermore, when the filler material of 3% OMMT was added to the hybrid composites, it led to a decrease in the impact strength of 30.5 kJ/m^2 in RSRS and 27.30 kJ/m^2 in SRRS subsequently. The reduction in the strength was attributed to the fact that the filler material reduced the compatibility and the adhesive nature between the reinforcement and the matrix phase.

$$\text{Impact Strength (I.S.)} = \frac{\text{Impact Energy in Joules}}{\text{Area of cross section in m}^2} \quad \text{.....(5)}$$

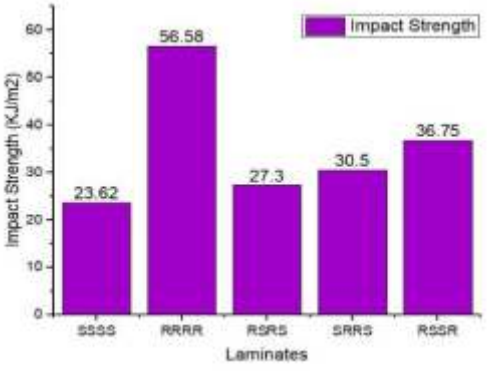

Figure 4: Impact strength of composites

4.5 Micro- Hardness

Figure 5 depicts the micro hardness of different laminates. The laminate RRRR, which consists of only ramie fibre layers with filler 3% material, exhibits 91 as the highest hardness number. The filler material, i.e., OMMT, shows resistance to the deformation in the material as well as the indentation on the laminate. The natural silk fibre incorporated composites showed a sleek hardness of 82, which is due to the softness of the material, resulting in effortless material deformation. In general, not much of a difference can be seen in the rest of the laminates, which show a hardness value of 87, 85, and 89, respectively.

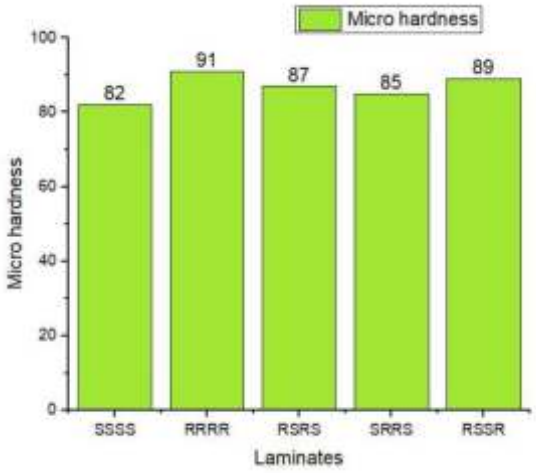

Figure 5: Micro Hardness values of different laminates

4.6 Moisture Absorption Test (MAT)

The specimens, after absorbing the water, will gain weight. The experiment continued for 30 days and was repeated frequently at an interval of 10 days in both normal and distilled water. Tables 4 and 5 shows the weights, before and after the duration in both conditions. The results showed that the water absorption percentage is higher in the RRRR laminate, a pure natural ramie fibre. Water absorption is less in the case of laminate SSSS, which had four layers of natural silk fibre. Because natural fillers are cellulose-based, plane hybrid composites have lower absorption capacity than filler-filled laminates. The specimen absorbed more water in normal water than in distilled water.

Table 4: Moisture absorption % in distilled water

Laminates	Weight of the samples before absorption (g)	% increase in weights		
Day 10		Day 10	Day 20	Day 30
SSSS	3.656	5.61	9.35	12.25
RRRR	4.451	8.62	14.32	18.36
RSRS	4.125	7.27	12.98	17.16
SRRS	3.961	6.78	11.32	14.65
RSSR	4.213	8.86	12.65	15.23

Table 5: Moisture absorption % in normal water

Laminates	Weight of the samples before absorption (g)	% increase in weights		
Day 10		Day 10	Day 20	Day 30
SSSS	3.556	5.21	9.55	13.25
RRRR	4.466	8.82	14.62	18.96
RSRS	4.115	6.97	13.19	17.28
SRRS	3.861	6.98	11.62	14.70
RSSR	4.220	9.02	12.75	15.86

4.7 Scanning Electron Microscopy (SEM)

The laminate fractured surfaces are used here to carry out the analysis of reinforcement–matrix blended interfaces. Initially, the surfaces are well coated with gold sputtering before image capturing to know the morphology. Figure 6 depicts images of Silk/ramie hybrid epoxy composites with and without filler. A solid interface of the laminate allows more stress transfer through filaments than a weak interface, though a weak interface produces a sleek bond between the fibres and the matrix [27] At the point when the power applied to the composite surpassed the interface bonding, a weak bonding basically empowered the filaments to pull out and break effectively, making the matrix split [28]. Case matrix break is presently the most prevalent failure mode, and it is in all likelihood associated with the brittle failure of SSSS composites delivered by huge fiber-to-fiber contact, as shown in Figure. 6A [29]. Another issue is inadequate fibre scattering, which brings about unequal fibre breaking when the stacked fibres are broken since they are not symmetric and equal. The tensile properties of plain ramie composites are the most reduced (RRRR). However, due to its single fibre properties, the morphological construction of RRRR (Figure. 6B) shows a greater number of fibre pull-outs, suggesting a weak interfacial association among fibres and matrix, bringing about diminished tensile strength. The fibre breakage on the fractured surface shows the less fibre pulled out in the hybrid composite RSRS, as found in Figure 6C. Due to the extent of inclusion of ramie fibre, the tensile strength and modulus of the hybrid composites have expanded. Individual reinforced fibre characteristics have the biggest effect on hybrid composite properties. [30]. Besides, various investigations have discovered that the hybrid composites' mechanical properties might be fundamentally influenced by various stacking arrangements. This review supports previous findings that substituting stacked fibres in composite materials increases tensile strength [31]. This is because of the way that the top and base layers of a composite are skin-covered. Since the skin factor decides the rigidity of the essential loadbearing part, picking a high-strength material as the skin layer can bring about higher tensile strength. As an outcome, axial stress might be

productively conveyed by the ramie fibre's external layers prior to being passed to the core layer.

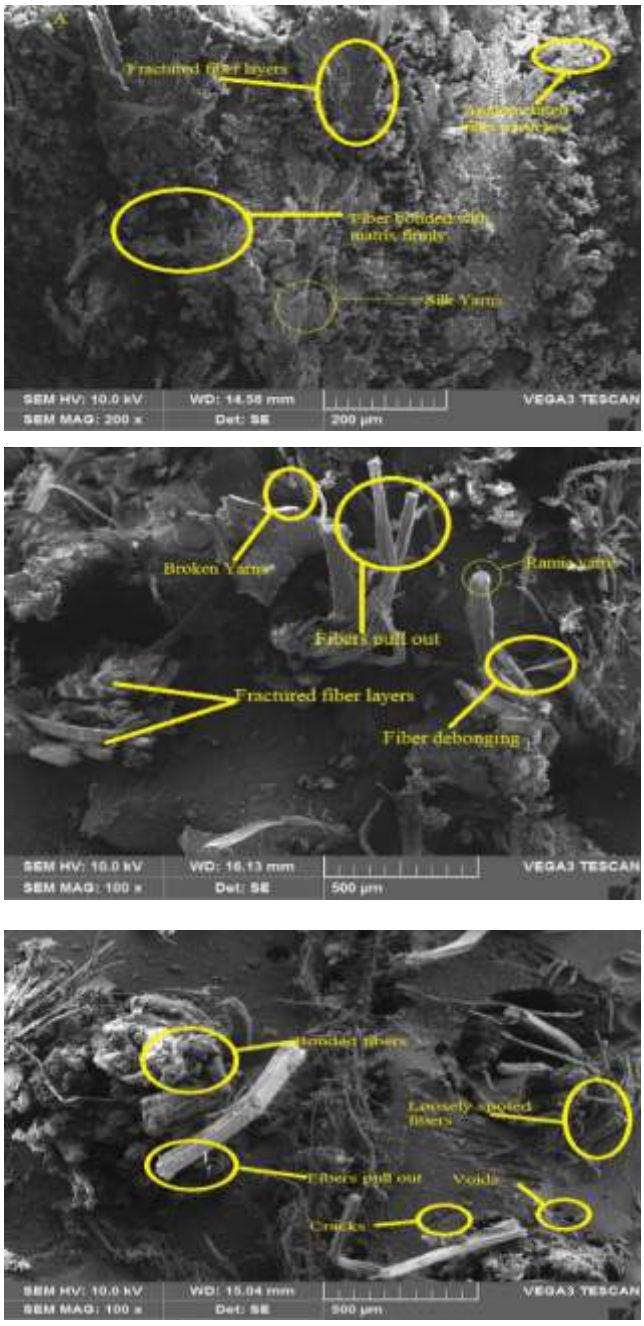

Figure 6: Scanning electron microscopy (SEM) micrographs of tensile fractured surfaces: A. Silk Fibre, B. Ramie Fibre, and C. Ramie/Silk Fibre Hybrid Composite.

5. Conclusion

In these investigational studies, successful fabrication took place with and without filler (3% of OMMT) for silk/ramie fibre reinforced epoxy matrix hybrid composites in the field of natural hybrid composite materials. The composite laminate being used is inspected for its different physical, mechanical, and microstructural properties. The results yielded only fewer voids in the case of RSSR laminates due to the incorporation of nano clay material in hybrid composites. Better properties were achieved in tensile, flexural, impact, and hardness tests on nano clay OMMT filled silk/ramie reinforced hybrid composite laminates and can be validated for their use in some medium-load structural applications. The behaviour of filler-filled hybrid composites affected the resistance to moisture considerably due to the presence of OMMT. The solid bonding in OMMT filler-based composites showed less void content that revealed the better adhesion properties between fabrics and epoxy matrix in SEM analysis. Henceforth, all the tests conducted above indicate that the hybrid composite with 3% filler OMMT gives better results. To ascertain the usage in large commercial applications, a few more tests are required to evolve the mechanical properties of the composites.

6. Acknowledgements

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Morphological Structure of Ramie for Acoustic

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Abstract:
Ramie a flowering plant in the nettle family Urticaceae, is considered as minor cellulosic fiber. Having beautiful brown colour, lustrous and good strength, these fibers are used for clothing since ages. As the extraction process is tedious and quality may differ depending upon the maturity, there are limitation in products. With the enzyme treatment the fibers were soften and changes in the structure will increase the commercial value of these fibers by using it for technical textile product. To identify the potentiality of the fibers for sound absorbing materials further an assessment was carried out to know structural changes by analysing both the untreated and treated fibers using various ASTM test methods – Bundle strength, SEM, FTIR, XRD and EDS. On comparing the results with previous studies, it was observed that the fibers are more aligned and porous which is needed for developing sound absorbing samples. Thus, these fibers were taken further to spinning and fabric manufacturing levels for the development of woven sound absorbing materials.

Keywords: *Eco-friendly products, Enzyme Treatment, Ramie Fiber, Sound Absorbing Materials, Structural Properties*

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1. Introduction

Sustainable and recyclable products are the need of the hour, as pollution levels are increasing day by day in India due to various factors. Noise pollution has become one of the major concerns for the physical and mental health both at work and residential. With the demand, one of the minor cellulosic fiber – Ramie was explored as acoustic solution. Ramie or Boehmeria nivea (L.) Gaud has a perennial shrub possesses good tensile strength, durability, lustre, microbe resistant property, but are glued together by gummy substance to hold the fibers together and are known as bundled fibers [1]. The mentioned natural characteristics alongwith the inherent hollow structure of the fiber is important factors to develop sound absorbing materials and so was explored to create woven fabrics having elements of aesthetics also.

Ramie, an earthy colour lustrous fiber can have another product line and thereby the utilization will increase. A non-hazardous pre-treatment procedure is needed to reduce the gummy substances of the fibers so that pliability increases. Thus, an experiment with a motto of commercial viability enzyme treatment was conducted which helps in water conservation as well as saves energy too. The treatment increased the softness, lustre and pliability of the fibers and further analysis was conducted to create functional products using the inherent properties.

2. Materials and Methods

2.1 Materials

Fiber Selection

To develop eco-friendly sound absorbing woven samples, ramie fiber was purposively selected based on the fiber structure, inherent properties and its availability. The procurement of un-degummed fibers was from Ramie Research Station, (CRIJAF – ICAR), Sorbhog, Barpeta, Assam. For the removal of all the impurities scouring process was conducted, which also helped in penetration of enzymes in the fiber structure.

Enzymes

Enzymes are a class of proteins that function as biocatalysts by lowering the activation energy of a reaction making it much faster. The enzymes were used for improving the feel of the fabric. Four different enzymes – Greenboost liquid (Pectinase), Biocool Z-20 powder (Hemicellulase), G-zyme axe liquid (Cellulase) and Denilite® || S (Laccase) were selected for the study and procured from Rossari biotech Ltd. and Novazymes A/S [3]. The enzymes during the treatment procedure penetrates into the fiber, act and reacts with each layer of the fiber and weakness lignin which is the main component that keeps the fiber stiffer. These enzymes interrelate with bonds and thereby the modification in the structural properties takes place by breaking or weakening the bonds. Table 1describes all the different stages of treatment with its process sequence [11].

Table 1: Coding of the raw and treated ramie fibers

Sr. No.	Codes	Description
1.	Rr	Ramie Raw
2.	Rhcbc	Ramie - High per cent concentrated – combing - beating – combing
3.	Rhcbc4	Ramie - High per cent concentrated (4hrs treatment without changing water) – combing -beating – combing

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2.2 Methodology

Enzyme treatment

With the conventional lab method, the treatment was conducted in which the fibers were soaked completely and was easy to rotate with less of entanglements. Standardized recipe and procedure of previous research was applied onto the fibers with M: L ratio i.e. 1:40, temperature 55℃ and 5 pH are as constant. Other variables like per cent concentration of the enzymes and treatment methods like padding mangle, beating and combing of the fibers were experimented. The optimized recipe was finally applied and considered for the study. The details of optimized recipe and treatment steps are mentioned in Table 2.

Sr. No.	Steps	Rhcbc	Rhcbc4
1.	Beating	10mins	10mins
2.	Combing	Combing of the fibers in small bundles	
3.	Pectinase	2%	2%
4.	Laccase	10%	10%
5.	Cellulase	7%	7%
6.	Hemicellulase	5%	5%
			Stepwise addition of enzymes in single bath
7.	Oil	25%	25%
8.	Batching	Overnight	
9.	Combing	Combing of the fibers in small bundles	

With the ongoing concept of water conservation, researcher treated two lots of fibers with same recipe but change in steps i.e. treating one lot (Rhcbc4) with all the four enzymes but without changing water. Then the fibers were immersed into the oil emulsion followed by batching treatment which improves the pliability by smoothing the surface texture of the fiber.

After standardizing the treatment procedure, further experiment was conducted for easy bulk treatment process alongwith proper rotation of the fibers so that enzymes penetrate equally in the fiber structure. Both the process was conducted using Infracolour and Launder-O-Meter machines. Finally, Rhcbc4 treatment procedure using Launder-O-Meter machine was carried out for the study based on two factors - the concept of water and time management alongwith the quality of fiber.

Evaluation of fiber properties

Subjective analysis (feel and touch method) and pliability test of all the three samples - raw ramie (Rr - standard sample), Rhcbc and Rhcbc4 (enzyme treated samples) were done. Porous structure of the fiber is one of the major factors to trap the sound. Thus, certain physical and structural properties of the fibers were analysed using ASTM methods.

Tensile strength with ASTM D 3822 was carried out on Llyod Instron Tensile Test for identifying the change in the strength of fiber after the treatment. The whiteness Index test was determined using CIE and ASTM D 1925 standard on Spectrophotometer instrument to identify the change in fiber colour. While to identify the morphological changes after the treatment four tests were conducted on Scanning Electronic Microscope (SEM), Fourier-transform infrared spectroscopy (FTIR), X-ray Diffraction (XRD) and Energy-dispersive X-ray spectroscopy (EDS). From the analyses one best sample was further selected for developing woven sound absorbing samples.

3. Results and Discussion

Physical properties

Ramie, a rough bundled fiber has nodes at various intervals when observed under the microscope. The brown lustrous fiber was found to be of 48 cm in length and each bundle of fiber consists of many sub fibers. The average diameter and denier measured between 79 µm and 739 respectively. The fiber is known for its good tensile strength and absorbent characteristics owing to its inherent hollow structure.

Tensile properties

The durability of any product depends on the strength, thus bundle strength of fibers using Instron machine was analysed and the details are given in Table 3.

Table 3: Tensile Strength of ramie fiber

Sample code	Maximum Load (gf)	Extension at Max (mm)	% Strain	Tex	Stress in gm/Tex
Rr	5407	0.39	12.87	242	22.34
Rhcbc	3167	0.69	23.13	153.2	20.67
Rhcbc4	3626	0.48	16	146.8	25.21

Ramie fibers are soft and surrounded by the rigid cellulose component. This cellulose structure is crystalline and porous but the removal of impurities was needed for smooth surface and good spinnability. Thus, the enzyme treatment given to the fibers might have removed the impurities and thereby the bonds have been aligned, which has converted the enzyme treated fibers stronger than the raw ramie.

The strength of the fiber has reduced after the treatment, which could be due to the changes in the nodes or maybe it is the impact of process during the treatment. The stress bearing capacity of the treated fiber Rhcbc4 has increased and thereby %strain increased compare to raw. The elongation being an important factor for spinnability has also increased in Rhcbc4 compare to raw. Thus, based on lustre, softness and spinnability Rhcbc4 showed best result and was selected for the yarn preparation.

Whiteness Index

The change in the colour of ramie fibers were observed after enzyme treatment, which is due to the removal of pectin, fats and waxed from the fiber. To identify the change in yellowness, whiteness and brightness was analysed by

whiteness index test. The purpose of this test was to understand the aesthetical properties of the product with the change of fiber colour. The details are given in Table 4.

Table 4: Whiteness index data of ramie fiber

Sample Code	Whiteness Index	Yellowness Index	Brightness Index
Rr (Raw ramie)	45.13	52.59	15.65
Rhcbc	49.72	52.88	19.19
Rhcbc4	53.91	41.02	24.20

From the results it was observed that more of whiteness was achieved in Rhcbc4 – enzyme treatment without changing water. While negligible difference was observed in the yellowness of both the fibers, which could be because of cellulase and laccase enzymes.

Scanning Electronic Microscope (SEM)

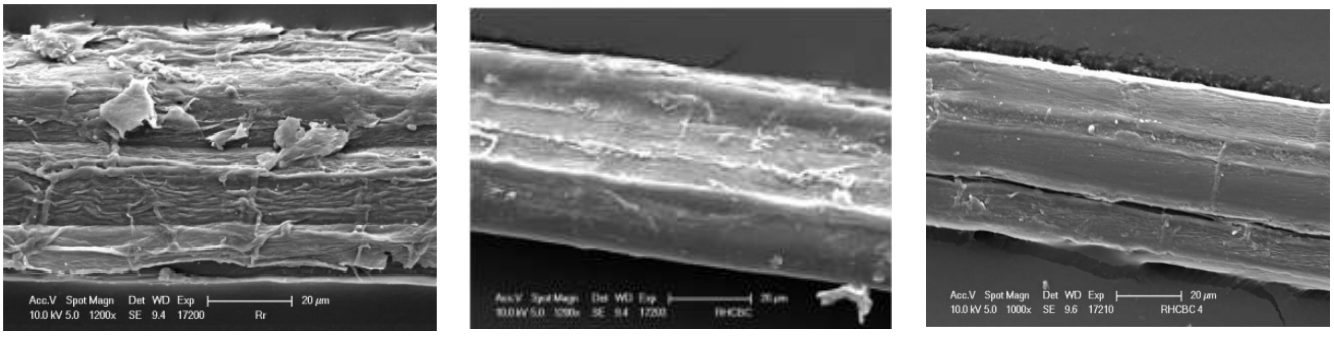
Scanning Electronic Microscope (SEM) was conducted to understand the morphological difference between untreated and treated fibers. In the hydrolysis process each and every enzyme reacts with the fiber, which consists hemicellulose, lignin and pectin. The raw ramie fiber is comparatively less dense with space in between the fibers; oval shape and variation in the size of the fibers were observed along with the lumen in the cross-sectional view of Plate 1.

Thus, the Rhcbc4 fiber showed changes in lumen part, is more porous in structure, more aligned and visible after the treatment, the pithy materials were comparatively removed by the enzymes. Hence based on the observation and need of the study sample Rhcbc4 were carried further for yarn conversion to develop woven sound resistant materials. The sound that will penetrate into the fibers will be trapped into the lumen or gaps within the fibers and to some extent the scattering of sound will also play a major role in sound resistance.

Fourier –transform infrared spectroscopy (FTIR)

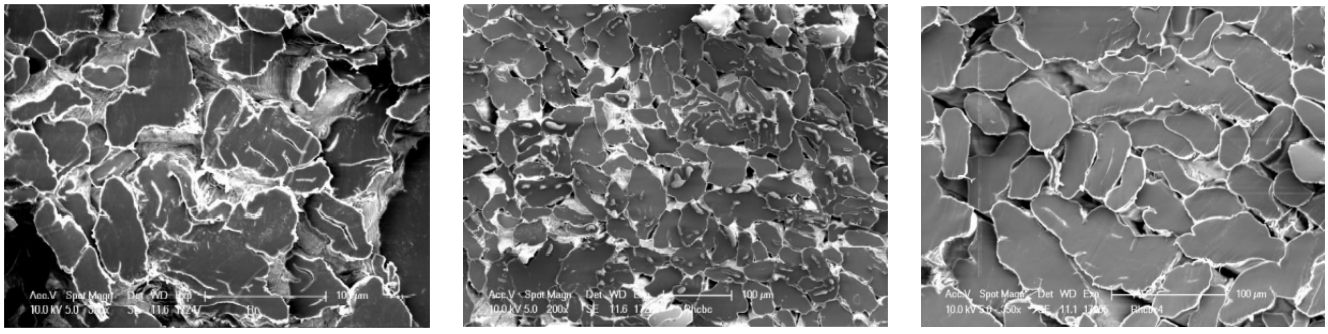
The FTIR spectra of ramie fiber samples shows similar peaks, but more prominent variation in intensity was observed in sample Rhcbc4 (Figure 1). Rhcbc showed a weak peak around 3500cm-1 while broader and deep peak was observed in sample Rhcbc4 which arranges from 3200 - 3500 cm-1 due to the bonded O-H group. Other uneven peaks were observed in the range of 1300-1600 cm-1, which are of C=O stretching, C-H deformation and stretching and C-O deformation bonds. However, in the case of Rhcbc4 a peak was observed nearby 1100 cm-1, which might be due to stretching and deformation of C-O and C-H bonds. All the mentioned ranges were associated with the lignin; hence it could be said that the treatment and process had an impact on the softening of the fiber.

Thus results also show that the treatment remarkably decreases certain components, such as cellulose, hemicellulose and lignin. The change in the components leads to the change in other properties, surface area and crystallinity of the fiber.



Rr | Rhcbc | Rhcbc4

a) Longitudinal View



Rr | Rhcbc | Rhcbc4

b) Cross sectional view

Plate 1: Longitudinal and Cross-section SEM images of enzyme treated ramie fibers with variation in process

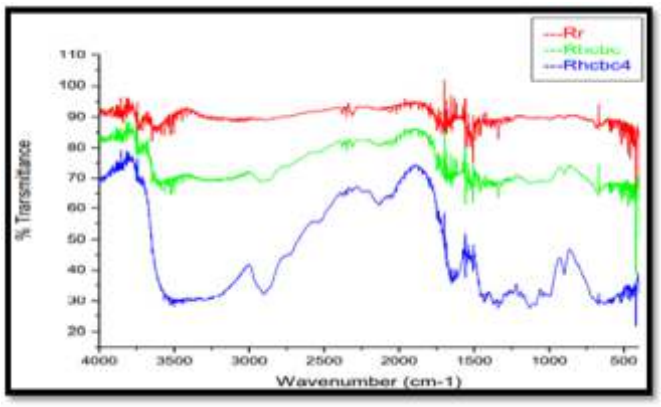


Figure 1: FTIR graph of untreated and treated ramie fibers with different process

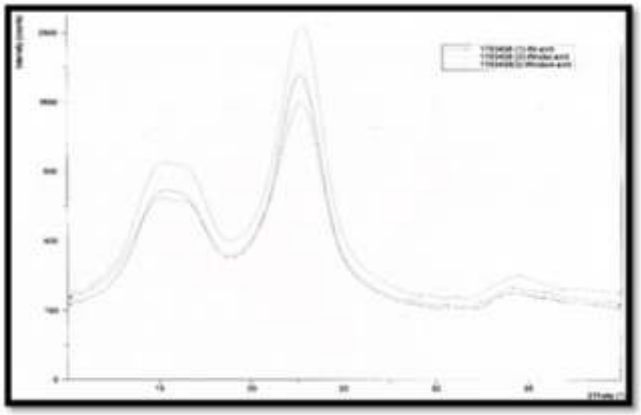
Thus results also show that the treatment remarkably decreases certain components, such as cellulose, hemicellulose and lignin. The change in the components leads to the change in other properties, surface area and crystallinity of the fiber.

X-ray Diffraction (XRD)

XRD analysis was conducted, from the data in table 5 it seems that destruction in the chains has an impact on crystallinity, crystalline size and orientation angle at 2 , in both the treated fibers compare to untreated fibers. Due to enzyme treatment the swelling in the chains was found in the SEM and thus the sample Rhcbc showed highest crystalline size. Additionally, the surface modification had a positive impact on pliability and this change in the property might assist in sound absorption also. Hence, with the removal of non-cellulosic compounds, crystallinity has increased and softness of the fiber was the resultant.

Table 5: XRD of bundle fibers scanned in Transmission mode 10-40°

Sample Code	Crystallinity (%)	Orientation angle at 2?? (°)	Crystallite Size (°A)
Rr (Raw Ramie)	81.77	14.3	32.42
Rhcbc	85.59	11.56	34.06
Rhcbc4	84.90	13.46	32.44



Graph 1: X-ray diffraction of untreated and enzyme treated ramie fibers

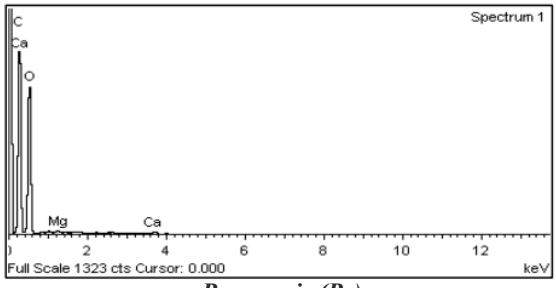
The X-ray diffraction of untreated (Rr) and treated ramie (Rhcbc & Rhcbc4) fibers are shown in Graph 1. Both the Rhcbc4 and Rhcbc shows rising peaks compare to Rr at 16° and 22°. Rhcbc4 shows peak at 16°, where the intensity of the peak has increased compare to the other samples with uneven broader width suggests the destruction in the amorphous region.

Energy-dispersive X-ray spectroscopy (EDS)

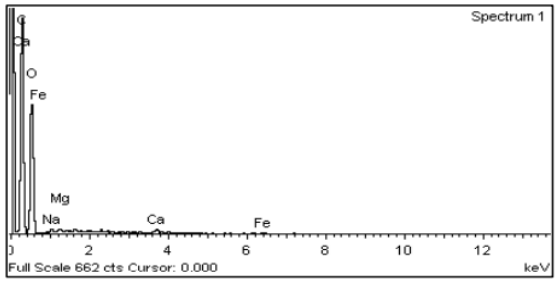
The treatment makes the changes in the bonds of the fiber. Thus, EDS analysis was conducted to know the change in the elements of the treated fiber and the details are mentioned in Table 6.

Table 6: Details of EDS elements of all the ramie fibers

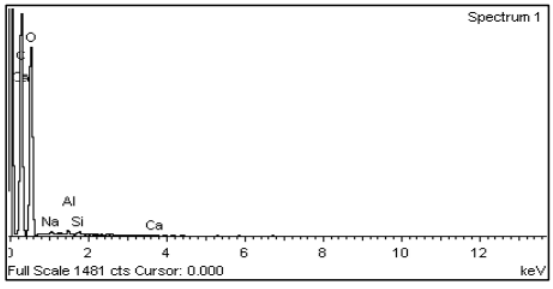
Element	Rr (Raw Ramie)		Rhcbc		Rhcbc4	
	Weight %	Atomic %	Weight %	Atomic %	Weight %	Atomic %
C K	27.21	33.27	27.07	33.17	27.13	33.19
Mg K	0.07	0.04	0.09	0.05	-	-
Ca K	0.15	0.05	0.16	0.06	0.04	0.02
O	72.57	66.64	72.35	66.55	72.49	66.59
Na K	-	-	0.20	0.13	0.21	0.12
Fe K	-	-	0.13	0.04	-	-
Al K	-	-	-	-	0.08	0.05
Si K	-	-	-	-	0.05	0.03
Total	100.00	100.00	100.00	100.00	100.00	100.00



Raw ramie (Rr)



Rhcbc



Rhcbc4

Graph 2: EDS graphs of untreated and treated ramie fiber

The elements present in the Ramie untreated fibers are Carbon (C K), Magnesium (Mg K), Calcium (Ca K) and Oxygen (O). Insignificant difference in the Carbon and Oxygen elements has been observed from the Graph 2. In both the treated samples – Rhcbc and Rhcbc4, reduction of calcium was observed. While, Sodium element is due to the use of Soda ash in the scouring recipe, which is in permissible limit. Additionally, elements like Magnesium, Iron, Aluminium and Silicon in the sample Rhcbc and Rhcbc4 respectively could be the result of reaction of enzymes with the metal body of the instrument or containers used during the enzymatic process.

Hence, all the changes and addition of elements were in permissible limits. So, the treatment recipe was effective, for the softening of the fibers and is harmless to the ecology and environment.

4. Conclusion

Ramie a lustrous fiber with hollow fiber structure is rough at the raw stage. To change the rough texture and improve spinnability enzyme treatment was carried out. Morphological changes were observed in the treated ramie fibers during physical and structural analysis.

The changes in lumen part, more porous structure and more aligned fibers will assist sound to penetrate, trap and scatter into the fibers. From the resources point of view, utilization of water and time has been reduced with the use of Launder-O-Meter, thus giving an opportunity to the experts to develop similar instrument to promote the ecological treatment process. Thus, with the sustainable process, a range of sound absorbing woven fabrics can be developed with aesthetical values.

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Robotic Applications in Garment Manufacturing: Revival of Garment Industry

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Abstract:

Robotic process automation is a software technology that makes it easy to build, deploy and manage software robots that emulate human's actions interacting with digital systems and software. Physical robots may be used in automation, but many robots are not created for automation. Robots are used to automate some physical tasks, such as in garment manufacturing. However, many types of automation have nothing to do with physical robots. Artificially intelligent robots are the bridge between robotics and Artificial Intelligence (AI). These are robots that are controlled by AI programs. Most robots are not artificially intelligent. Up until quite recently, all industrial robots could only be programmed to carry out a repetitive series of movements which do not require artificial intelligence. However, non-intelligent robots are quite limited in their functionality. The applications of robots in fashionable garment manufacturing have seen tremendous infusion of technology in the manufacturing plants. The robots are effectively used in Fabric Inspection, fabric spreading, fabric segregation, cut piece assembly, garment pressing and garment packaging. This present paper deals with an indepth and extensive applications of Robots in apparel manufacturing.

Keywords: *Artificial Intelligence, Fabric segregation, Physical robots, Robotic process automation, Software robots*

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1. Introduction :

Automation and robotics are the two terms that are often used interchangeably. Automation is the term pertaining to all the process based on using mechanical processes, computerized software and additional engineered machinery to accomplish those tasks that are usually performed by human workforce. Automation has many levels, ranging from the entirely mechanical to the wholly virtual and also, from very simple designs to the mind-bogglingly complex configurations.

The Robotics is the term related to the process of designing, developing and applying robots to execute plentiful tasks. In addition, Industrial automation relates to the processes of automatising various physical processes using shop-floor robots and their dedicated controllers. On the other hand, Software automation is the extensive use of software to perform the tasks performed by computers. There are abundant categories of software automation as test automation, robotic process automation, intelligent automation, and many others. Robotics engineering refers to the design and development of robots by incorporating software, hardware, sensors and other devices, for quality inspection, assembly, packaging, handling etc [1].

1.1 Robotics as an integral part of automation

The processes that utilize the application and combination of mechanics, electronics and computer based systems to operate and control the apparel manufacturing systems and their support systems is termed as AUTOMATION. It's the use of mechanical systems, control systems and web based technologies to implement suitable control on the apparel production. A robot is the technological advancement concerned with the accomplishment of a dedicated process with the use of structured commands may be combined with automatic feedback control systems to ensure the proper execution of the process. The broad areas of application of automation encompass manufacturing departments and manufacturing support systems. The typical areas to be covered in the automation of manufacturing departments of a garment industry are 3D Body scanning, Automation in fabric & trim inspection, fabric spreading, fabric cutting, garment sewing, fusing, moulding, welding, garment pressing & packaging, workflow systems, Robots, Programmable Logic Controllers, Automated Geared Vehicles, Art work processes and Computer Integrated Manufacturing (CIM) [2].

On the other hand, the computerization of manufacturing systems is about the reduction of human participation to only supervisory control and elimination of the clerical/manual work carried out by the human assistance especially in the product designing, planning, assisting and product control and process control. The various segments affected by automation in this are MRP (Material Requirement Planning), Lean manufacturing, Agile manufacturing, MRP II (Management Resource Planning), JIT (Just In time), Inventory Management & Handling, MIS (Management Information System), CAPP (Computer Aided Process Planning) and ERP (Enterprise Resource Planning) [3].

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Robots are able to fit into the genre of flexible automation due to its unmatchable capabilities of reprogramming, ease of changeovers, efficient and error-free task accomplishment.

1.2 History of Robotic Technology Evolution & Developments

The robot history is the amalgamation of fiction and real time technological advancements. The first modern automation was invented in the year of 1810 by a German artist Friedrich Kauffman. The initial prototype of this robot looked like a soldier equipped with automatic bellows to blow a trumpet. "Robot" term came from the Czech literature that meant "forced labor." They looked like humans but instead of metal, chemical batter was used to produce them. In the 1950s, George Devol designed a revolutionary "Unimate", a robotic arm device that transported die castings in a General Motors plant in New Jersey in 1961. In addition to it, by mid-1950s, the German firm "Kuka" developed an automated welding line for appliances as well as a multi-spot-welding line for Volkswagen. After this, by 1970s, Stanford University designed the "Standard Arm" to be used for small part assembly for the incorporation of touch and pressure feedbacks. In 1973, Kuka had introduced the six-axis robotic arm, which became an industry standard after its commercialization [4].

At the same time fully electrical systems based robots began to emerge in the Industrial arena. By 1970s, many new endeavors were tried for Robots as a microprocessor-controlled robot, increased ability to handle higher payloads (ability to lift high weights), a sensor-based welding robot, development of the SCARA arm and PUMA robot for small parts assembly, hand on trials of basic robot programming languages & Speeds and capacities were also worked upon tremendously. In 1990s, first packaging robot was innovated with pure robot controls and synchronizations. The onset of 21st century had completely revolutionalized the robot technology with the invention of a handheld teach pendant, robot multi axial synchronization, Automated geared vehicles, Collaborative Robots (COBOTS) and Autonomous Mobile Robots (AMR) by 2010. The progression of the Robotic developments is depicted in Figure 1.

1.3 Robotic applications in the garment manufacturing processes

The requirements of the Robots for the Garment Industry are entirely different from those required by the other hard core manufacturing plants due to the complexities involved in the assembly and handling of textile materials in raising the garments. The major challenges implicated in the infusion of the Robots in the garment manufacturing include the use of extremely limpy, unstable and delicate raw materials as fabrics, threads and notions; high speed processes; minuscule labor intensive processes; huge diversity and variability in the raw materials in each lot and requirement of human intelligence and intervention in all the processes to some extent. These challenges posed by the garment Industry had deferred the use Robots in this specific segment of production Industry. But with the advent of Science, Engineering and Technology, even the Garment Industry hasn't remained unscathed for the Robotics [5].

The design of Robots for the garment manufacturing has always required different class of manipulators and its subparts, control systems and driving mechanisms to suit the requirements of the variable garment making steps just as movable platform based manipulators are always preferred for the material transfer within a department; use of combined pneumatic and hydraulic drives for assembly of garments; variety of sensors as touch, tactile and vision systems are the most common preference for fabric spreading, cut fabric segregation and seaming of cut parts; special designs and materials for grippers & end effectors based on the clamp, pinch, pins, vacuum, air jet blow principles are devised to suit the raw material variables as Materials type, Weight per unit area, Thickness, Wettability, Stiffness, Hairiness, Permeability, Friction, Elasticity and the ability to keep an electric charge [6].

2. Robots in Fabric Spreading

In this area, Robots are used for the identification of the fabric defects, shade matching of different plies, adjustment of ply tension during the spreading process. This is made possible by employing different types of touch, tactile and vision sensors to the manipulators. The major challenges posed by this process line to the use of Robot is that these programmed

Figure 1 - Evolution and development of Robots from the infant stage to the modern forms

machines are not able to distinguish various fabric weaves and patterns or other types of fabric details during ply matching as shown in Figure 2.

Figure 2 - Spreading process with the interface of Robots

3. Robots in Fabric Cutting

Robots are used with two main perspectives in the garment cutting room. In the first scenario, the robotic arm is equipped with the cutting aids as drills at the position of its manipulator grippers. This will eliminate the need of manual drills for the cutting room. In the second perspective, the Robotic arms are interfaced with the cutting tables to sort the cut pieces from each other as front, back, sleeves, pockets, collars etc. either bundling cum ticketing or for UPS production lines to be transferred to the next production processes as can be seen in Figure 3. In this, the exact position of each cut part and its suitable picking points should be programmed along with other details as decisions have to be taken on what is to be picked and where is it required to be delivered. Highly sophisticated tactile sensors are required to accomplish this task. The clamp and pinch type of mechanical grippers can be chosen with the two sided attraction and of handling and mechanical gripping principles. Clamp grippers are successful in fabric ply picking and also ply separation [7, 8].

Figure 3 - Fabric cutting with the specialist robotic arms

4. Robots in Garment Assembly

The most complicated automation and robotics are used in sewing section of the garment industry. This is due to the reason that sewing process employs very small and yet complex tasks for garment assembly. Also, the variety of tasks, machine settings according to the raw materials and raw material composition further makes the integration of Robots more challenging. There are numerous approaches in which robots are used in the garment assembly.

In the first approach, Robots are used in material handling between the sewing processes. In the second approach, Sewing robots as "SEWBOTS"– Robotic sewing- It is the advanced technology that is based on the combination of machine vision systems and pneumatic robot drive systems to maneuver the fabric compositions upto and from the needle with greater speed and accuracy than humans can achieve. It is commercially applicable in the automated production of different types of floor coverings as bath mats, carpets, rugs, automotive textiles, medical textiles, bath towels and several categories of 3D composites. The fabric compositions are fed by soaking them in highly diluted liquid polymers solutions to turn them into thermoplastic hard composites that robots can easily handle. The sewing machine assembles the stiffened compositions of fabrics to produce a neatly seamed product. After sewing the fabrics, the polymers are washed off with running water without the need of detergents (Figure 4). Sewbots suffers from a few limitations as fabrics like wool or leather can't be easily used with this technology as they can lose some of their properties while getting wet [7, 9].

In another approach, stitching robots are equipped with the sewing zones to assemble the preformed composites for automotives, as earlier flat sewing techniques are not suitable for these preformed 3D auxiliary automotive parts due to their large dimensions. In this interface, the workpiece is fastened on to the fixation devices and the stitching heads are carried along the seamline of the resting workpiece. One side stitching is only performed in this mainly with single thread chain stitches. Other approaches of robots include the integration of robots with already existing sewing units.

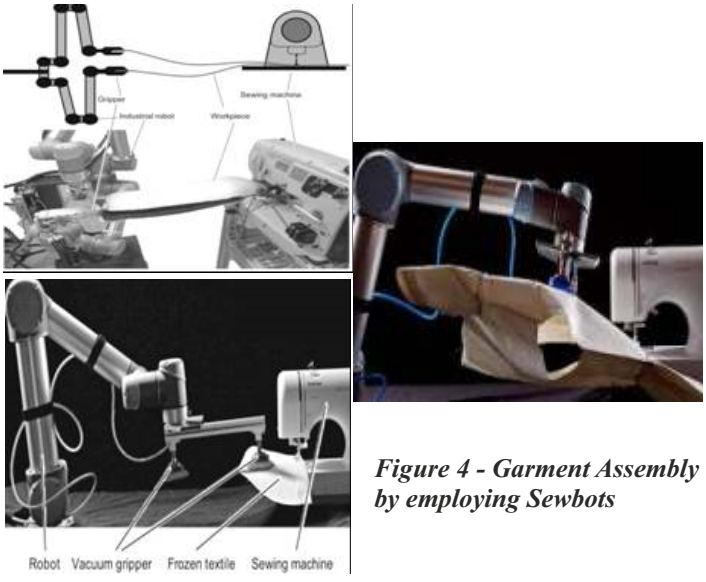

Figure 4 - Garment Assembly by employing Sewbots

5. Robots in Garment Packaging

In addition to manufacturing, machining and assembly; robots can be used for garment packaging, cartoon sorting and order picking. Variable types of grippers and gripping principles are employed for the robots to order pick and package the ready garments as per the packaging materials. Clamp type of grippers is the best choice for the garment packaging robots interlaced with the packaging workstations for garment sorting, picking them at the correct positions by using two attachment points with the options of changing the distance between them to handle wide range of textile materials as shown in Figure 5. In addition to it, specially designed Pinch grippers are also used to pinch the textile materials using soft tipped fingers while packaging. The design of this gripper has followed the engineering design principles with low cost, non-destructive, minimum DOF and cycle time [10].

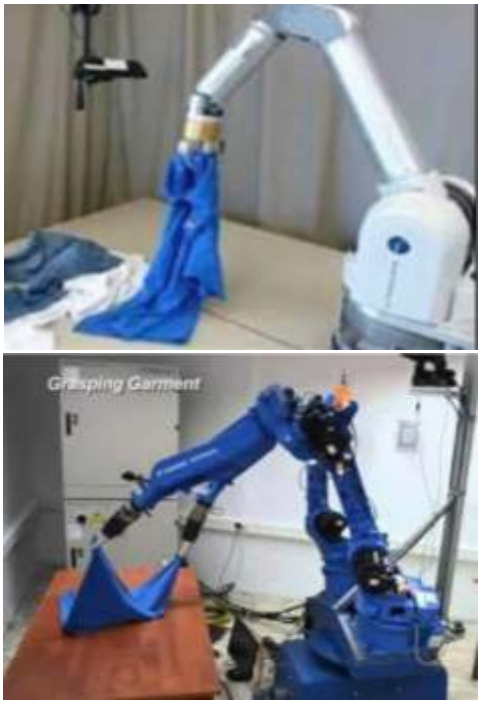

Figure 5 - Garment folding and Packaging by dedicated Robotic arms

The leading manufacturers of robotic assemblies providing solutions to the garment industries include Siemens Technology in association with Sewbo Inc., Bluewater Defense and University of California at Berkeley; Interface Technologies, Hickey Freeman; Yaskawa Electric Corporation (Japan); Universal Robots (Japan); Universal Robots (Japan) and Midea Group (Kuka of Germany).

6. Conclusion

The applications and success of robots in the garment industry was long awaited till 21st century. In the current scenario, most of the segments of the garment industry have been able to employ the robot technology to the pinnacle of success. But the newer face of the Industry have brought many provocations as it has led to unrest among people due to the reduced requirement of the labour, thus leading to increased unemployment, need of only literate and technology compliant workforce, massive initial capital and maintenance investment, lacking creativity and many more. Yet the changing implications of automation and robots in the current fashionable garment industry will surely give innovative horizons to the manufacturers, designers and consumers as well.

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Macro aspect on Maintenance of Conventional Looms

Mr. S. Srinivasan

Abstract: Maintenance of machines is one of the important functions of "Operation" of Weaving Units. It has significant effect on conventional looms, on production, quality, Repairs & Maintenance (R&M) cost, power cost, number of maintenance staff, re-sale value and machine life. The broader aspect of maintenance like the management role, the O.R. model on "Time to replace the Machine" are discussed.

A) Introduction

The Power-loom sector in India, is largely of small and medium size, dominated by conventional looms. This sector has come up essentially to circumvent the burden an organised (weaving) sector carry on payment of, (I) minimum statutory wages and (ii) higher power tariff. Often, piece rate wages- system and production predominantly for job work, are practised in this sector. They avail some power tariff concession in some States, given to MSME sector.

The output of the units in this sector, is unprocessed fabric called" Grey" fabric. The viability of a weaving unit in this sector, largely depends on, quality and quantity of loom output, Proper Maintenance of looms, has a great impact on both these aspects. The micro aspect of "Maintenance", namely, machine cleaning, lubrication, replacement of missing, broken, worn out parts, settings etc., are not discussed here. However, the macro (or) the broader aspects of it are spelt out in brief. Large set up time and poor maintenance results in loss if capacity. The present market demand smaller lot size, meaning frequent set up and large set up time, adds significant cost to smaller lots thus losing competitiveness. Control on the set up time reflects the ability of an organisation to change over from one product to another.

B) Macro-aspect of Maintenance

a. At the time of construction of building and installation of machines, attention should be paid by the. "Management" to:

i. Proper departmental, as well as machine layout, considering the point of receipt and delivery of goods, the material handling equipment to be used etc. The alley should be wide enough to bring the weaver's beam and doff and carry the "grey" cloth to the inspection dept. The location of sections of, a) beam drawing, b) humidification, c) work shop, d) inspection, e) stores and f) Weaving Mangers office (with a glass window for overall view of the entire loom shed) should be meticulously decided. Once laid, any change will be too costly.

ii. The Flooring should be sturdy and even, facilitating smooth transportation of the material carried.

iii. There should be adequate Lighting for the weavers to attend to, a) warp breaks, b) weft breaks and c) to attend to fabric defects and so on.

iv. Safety aspects as per the "Factories Act" should be followed.

v. Providing work shop with basic facilities, providing, adequate Tools and tool boxes individually to the fitters/mechanics, building proper storage facilities for the tools.

vi. Periodical Training to the maintenance staff on Maintenance of loom is required. Apart from imparting knowledge on the settings and functions of various mechanisms of a loom, some basic theory on weave, fabric defects etc. should also be the part of the training programme.

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

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

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C) Top management Commitment on the following are necessary

i. Adherence to preventive maintenance schedule as recommended by the machine manufacturers,
ii. Ensuring availability of spare parts,
iii. Use of standard parts,
iv. Over hauling once in at least 10 years etc.,
v. Recording M/c history: This is very important to find the defective machines and within that defective mechanism.
vi. Insistence of proper "Planning", especially on the activities during beam-fall to reduce the m/c down time is necessary.
vii. Organisation Structure: Maintenance Head-should not to be under Production Head.

D) The Maintenance Team: The team should get a special attention, as they are the back bone to present a machine in a good condition. Even a best operator cannot offer quality and adequate output, if a machine is defective.

i. Machine Audit: It should cover all the looms in one year. The cycle for checking the loom RPM is one month. Often variations in loom speed go unnoticed. Due to poor mechanical conditions, "Jobbers" reduce the loom speed. The loom running at slow speed should be identified and corrected. Operator(weaver) should be made the initiator to identify the looms under him for more warp/weft breaks, "shuttle-fly" and the jobber/fitter should identify the parts that are consumed in excess (than the standard) in general or in specific looms (E.g. Shuttle and buffer consumption).

ii. Case -1 (Source: Refer item-1 in the Reference Section)

When to replace?

To say in a nut-shell.in this article, the cost that changes with ageing of a machine is taken. The investment cost is fixed and does not change as the year passes on usage. But, the scarp value (or the resale value), power cost, Maintenance cost on Spares, fitters etc., increase. The defects increase, the machine speed reduces. The cost effect of all these is considered to decide when the machine should be replaced.to have minimum annual average cost that includes investment and running cost. A similar model is discussed in Case-2.

iii. Case -2 (Source: Refer item-2 in the Reference Section---suitably modified)

Frequency of Preventive Maintenance -

A weaving unit has 50 conventional looms. The Preventive Maintenance (P.M) cost if taken up at a time on all the looms, is Rs.2000 per loom (or) Rs.100000/- for all the 50 looms. The break down maintenance (B.M) cost, if taken up as and when the looms break down, is Rs.10000/ loom- The probability of break down after a Preventive maintenance service is given below. The Weaving Unit seeks the frequency of preventive maintenance service to get minimum average cost p.a. Advise the Weaving Unit.

Table 1 -The average time before a br. down occurs on loom is given below

Year after P.M.	Probability the Br. down will occur
1	0.10
2	0.05
3	0.05
4	0.10
5	0.15
6	0.15
7	0.20
8	0.20
Total	1.00

Year after P.M. (i)	Probability the Br. down will occur (p)	(i)X(p)
1	0.10	0.10
2	0.05	0.10
3	0.05	0.15
4	0.10	0.40
5	0.15	0.75
6	0.15	0.90
7	0.20	1.40
8	0.20	1.60
Total	**1.00**	**Avg. =Sum(iXp)/1=5.40**

The data show that, no loom can work without failure beyond 8 years. All the looms fail within 8 years, and the average failure (br, down) rate is 5.40 years. When B.M is followed (with no P.M), the average cost per annum is =

Total loom X BM cost per loom/average failure period=50X10000/5.40=Rs.92,593 (A)

Table 2 - When P.M is practised, the average annual cost is arrived at as follows

(i)	(ii)	(iii)= (ii)X10000/(i)	(iv)= 100000/(i)	(v)= (iii)+(Iv)
Yr. after P.M	**Expected cumulative br.downs(*)**	**Avg B.M cost p.a. (Repair Cost)**	**Avg P.M cost p.a**	**Avg P.M + Repair Cost p.a.**
1	5.00	50,000	100K	150K
2	8.00	40,000	50K	90K
3	11.05	36,833	33.3K	70.1K
4	16.75	41,875	25K	66.9K
5	25.63	51,260	20K	71.3K
6	35.50	59,167	16.7K	75.8K
7	48.72	69,600	14.3K	83.9K
8	63.46	79,325	12.5K	91.8K

(*) see table below.

The looms that failed in Yr-1 will be attended to (as per B.M cost) and after one yr, it will fail again as per the probability shown for Yr-1 (i.e. 0.1), i.e.5X0.1=0.5 looms will fail in Yr-2. Thus 2.5 looms from the 50 looms and 0.5 looms from the 5

Table 3 - The expected cumulative br. down (shown in Col.2 of Table-2) is taken from last col. of the Table below

Yr	N_0	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	Tot.	Cumu
		5.0	3.0	3.05	5.7	8.87	9.88	13.22	14.74		
1	5									5.0	5.0
2	2.5	0.5								3.0	8.0
3	2.5	0.25	0.30							3.05	11.05
4	5.0	0.25	0.15	0.31						5.7	16.75
5	7.5	0.5	0.15	0.15	0.57					8.88	25.63
6	7.5	0.75	0.3	0.15	0.29	0.89				9.87	35.50
7	10	0.75	0.45	0.31	0.29	0.44	0.99			13.22	48.72
8	10	1.0	0.45	0.46	0.57	0.44	0.49	1.32		14.74	63.46

looms that was attended to in Yr-1 (total 3 looms) will fail in Yr-2 and will be attended to (at the B.M cost).

The (5.0) looms that failed in Yr-1 after repair, will fail again after two years i.e. in Yr-3, as per the probability shown for Yr-2 (i.e. 0.05), i.e.5X0.0.5=0.25 looms will fail in Yr-3. Similarly, the three looms that failed in Yr-2, will fail after one year as per the probability shown for one year i.e.0.1. (Or), 3X0.1=0.3 looms will fail in Yr-3. Thus, in Yr-3, 2.5 looms from the 50 looms,0.25 looms out of the 5 looms and 0.3 looms out of the 3 looms, (total=3.05 looms) will fail in Yr-3 and will be attended to (at the B.M cost).

N1=The first row, Col. 2, in Table 2 is the no: of failures in Yr-1(which is same as total for Yr-1)

N2=The figure in the first row in Table 3, is the no: of failures in Yr-2(as explained above) and it is the total for Yr-2, so on for first rows of N3 to N8.

Interpretation of Table 2: From the last col. it is clear that when P.M is followed, the average annual cost reduces every year till end of Yr-4, and then it increases every year for ever. The minimum avg. cost p.a.is achieved when P.M is taken up after every four years. Then, the cycle repeats for every four years with an avg. annual P.M +B.M cost of Rs.66.900/. When B.M alone is followed, as shown in Item (A), the avg. annual cost is Rs.92,593. Thus on following P.M. there is a saving of 92593-66900= Rs.25,693 p.a.

It is important to note the condition that B.M cost per loom (Rs 10,000) when done as and when they fail, should be more than the P.M cost per loom (Rs 2000) when taken up on all the 50 looms at a time. If the difference in the cost is small, the table will suggest taking up P.M after a long period and vice versa. Similarly, when the P.M cost is high, the table will suggest taking up P.M. after a long period and vice versa.

E) Conclusion

Quite a number of Managers involved in the decision of replacement of machines- or preventive maintenance- especially of small and medium sized units, are not able to use the suggested tools, due to absence of the required cost/revenue information. The correctness of the decision depends on the accuracy of the cost information fed. This means recording of information of the various costs that change with the age of the machine is required. Nowadays, with the adoption of SAP/ERP modules, collection of such cost information for each machine or a set of machines are possible, thus enabling correct decisions related to Machine

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Texpreneurs Stories of Mr. V. V. Gharat
- MD, Gharat & Associates

Mr. Prati Ghadia, Founder & MD of Yarn Bazar interviewed with Mr. Vilas Gharat on his business journey and the activities.

Q.: Could you tell our listeners something about yourself and your textile journey so far?

ANS.: First of all, I am very much thankful to all of you for giving me an opportunity to get associated with your organization. It is my pleasure to introduce me to your listeners in brief;

- I am proud son of Ex-Indian Army Man. Similarly, I am proud to mention that I have completed my education in VJTI by driving taxi at Night in Mumbai city.
- I passed out my Textile Engineering from VJTI in 1968. Since then, I have been serving textile industry till date having more than 50 years' experience in managing textile units effectively & profitably.
- I started my professional journey as Trainee in India United Mills No. 1 (Supari Bag) in Spg. Section having 1 lack & 99 thousand spindles. It was great experience working under Mr. Bandekar Spg. Supd., who was task master.
- I was associated with reputed textile groups as Business Head in India & Abroad.
- The major groups are Thackersey group-working under KMD Thackersey & Mr. Vijay Marchant. The Crown Mills experience & learnings is reason for getting Job in Indonesia - PT Derelon under Ashok Birla group.
- Chouwgule Group (Goa) is my turning point as Efficient Business Head directly working under Mr. V. D. Chauwgule.
    - Tata -Finally Mills (NTC)
    - Shriram Mills (S Kumars)
    - Bothson Group (Nigeria)
    - Singhania (JK Cotton)
    - Morarjee (MBL)
    - Ashok Oswal Group (Hammerle)
    - S Kumars group many assignments till date

After retirements from MBL in 2005, started Gharat & Associates rendering service to textile industry till date. Completed 4 Textile Projects from conception to implementation. (Major JV Oswal Hammerle), Kagal, Kolhapur.

I strongly believe that Your Success in my Satisfaction & everything can be done online except manufacturing. So, manufacturing with required quality & quantity on time is key for success.

Q.: How did you choose this industry? Was there a specific reason behind it?

- **ANS.:** The main reason to choose Textile Industry is my uncle was working in Textile Industry as Carding Master & I am fascinated with new designs with varieties of garments.
- Getting admission on merits in VJTI Textile Engineering was pried on our days.
- I still like to be well dressed with latest outfits & designs. It is my passion to create designs & garments to make people presentable.

Q.: If you could tell us your views on the recently introduced PLI Scheme?

- **ANS.:** The Production Link Incentive (PLI) is defiantly encouraging scheme to larger units. The investment pattern starts from 100 Cores & it is mainly to technical textiles with manmade fibers.
- We are cotton growing country & hence I wish cotton industry should have been included.
- Similarly, it should be modified for small & medium units.
- Along with PLI there should be some scheme for marketing also because we are lacking in aggressive marketing.

Q.: Tell us about the Textile Association (India), its different activities and how textile professionals can associate with the same?

- **ANS.:** The Textile Association (India) is established on 9th April, 1939 to serve textile Industry & technocrats. Presently we have 26 affiliated Units with more than 25,000 members across India.
- It is National body of textile technocrats & professionals in India.

- The Association is having excellent talent banks as members & Office Bearers who are organizing Seminars, Webinars & many technical papers to enhance knowledge of members.
- Association is publishing JTA magazine regularly to update latest technology & textile policies.
- Association expert members have created amazing booklet named as Tablet with concept take tablet before staring your day for section wise heath.
- Association is conducting certificate course for members. ATA / GMTA.
- Association is also giving awards to deserving candidates -FTA / Service Gold Medal / Industry Excellence/ Best unit award,
- I have joined as life member in 1985 Mumbai Unit with shouldering repositories as Past Vice Chairman, Past President.
- At present Board member of Trustees till 2025.
- It is my passion to serve textile industry & hence still actively working without any expectations.
- Textile Industry have been passing through ups & downs for years & association play important role in supporting members.

Q.: Where do you see the textile sector 5 years from now?

- **ANS.:** As mentioned earlier Textile Industry will never die but only can survive on costumer's delight.
- Looking to present scenario & cost escalation I firmly believe that new entrants with positive business attitude will create huge impact in business growth in next 5 years.
- Textile is low margin business hence developed countries may not utilize their costly labor. Hence low-cost countries will prosper in next 5 years.
- India can be benefitted provided RM cost fluctuations are avoided by Govt. of India.
- Similarly, those who will create infrastructure to manage new & changing product basket will prosper.
- Those who will take care of consumer's satisfaction will defiantly prosper.

Q.: Any specific threat or roadblock that you see people are currently facing or will face in the future?

- **ANS.:** Textile Industry is clothing the people with varieties of garments having different colors & designs. We assist human being to create pleasant look with suitable outfit-garments & therefore customer's choice is very important.
- It is observed that we are giving more attention to productivity instead of costumer's requirements & hence we pile up stocks.
- We never study market demand.
- We should plan sold production program as per market requirements.
- We should have costumer's service department to serve before & after sales of your products.
- Changing product baskets as per new market trends.
- Daily cash flow monitoring Daily P/L - Padta

Q.: What is the most important thing you have learnt in your life? How has this changed you as a person?

- **ANS.:** As mentioned earlier I have been driving taxi at night in my entire VJTI journey. Those 3 years change my perception that any work you do with honesty -hard work will defiantly reward you.
- I used to have many passengers at night every day which made me to understand people intentions.
- I met many good & bad passengers which made me to understand human nature.

Q.: Advice for the younger generation and entrepreneurs.

- **ANS.:** Do What You Love & Love What You do.
- Honesty & Hard worker never requires any Godfather.
- There are two types of people in every organization-1) Chamcha 2) Honest & Hard workers but in case of emergency Chamcha is kept aside.
- Failure is 1st step of success.
- Admitting mistakes with proper analytical reasons for improvement is key for success.

Fill in the blank:

- Textile Industry is ever lasting industry & will not die as long as humans are wearing clothes.
- Textile Industry help human being to be presentable in society.

Rapid Fire:

- Rieter or Trutzschler –Trutzschler
- Reading book or Listening Podcast -Listing Podcast

Q.: What will be the first thing you will do, if you become textile minister for one day?

- **ANS.:** I don't believe in miracles & hence never tax my brain which will not happen.
- So, one day minister is ruled out but I have strong desire to be task force leader under NITI Ayog for upgrading textile industry.
- Under Hon. Modi ji NITI Ayog is doing wonderful jobs for many areas for survival of up-gradation.
- Similarly, if I get opportunity to be Head of Task Force will help Textile Industry to formulate effective policies with efficient implementation.
- Under NITI Ayog we can assist sick units to improve their financial health by providing proper solutions & support.

Vilas Gharat
Managing Director - (Gharat & Associates)
Mentor of Change - (Atal Innovation Mission -NITI Aayog), Govt. of India.
Board Member of Trustees – The Textile Association (India) - Mumbai Unit
E-mail: vilasgharat@gmail.com

Seventy Years of Success of the CHT Group

The CHT Group celebrates its 70th Anniversary in 2023 - a good occasion to review and look back on seventy years of Smart Chemistry with Character.

The CHT success story began in 1953 when Reinhold Beitlich founded the "Chemische Fabrik Tübingen R. Beitlich GmbH" – today: CHT Germany GmbH - in Tübingen. In its very first year of business, CHT achieved sales of around EUR 235,000 with 13 employees. Until the seventies, additional warehouses, production and shipping halls, administration and laboratory buildings were built almost every year.

During this growth phase the first subsidiaries were founded in Austria, France, South Africa and in Switzerland. In 1980, the Swiss subsidiary, today's CHT Switzerland AG, took up dyestuffs as a second pillar alongside textile auxiliaries and has since become CHT's competence center for dyestuffs. Due to this expansion phase, Tübingen became too small as a production site, so that in 1972 the new production site in Dußlingen near Tübingen went into operation. Today, CHT continues to expand, with subsidiaries and corporate acquisitions, on all continents.

Since 1983, all companies of the CHT Group have belonged to RB Beitlich Industriebeteiligungen GmbH (RBI), which is privately owned by two foundations, the Beitlich Family Foundation and the charitable Reinhold Beitlich Foundation. This constellation ensures the independence and long-term continuity of the company as well as the steady expansion of CHT's core competencies of innovation and sustainability. The charitable Reinhold Beitlich Foundation ensures that part of the company's success benefits charity projects.

Already in the 1990s, CHT recognized that diversifying its product range beyond textiles was important for an economically strong company. In 1997, with the purchase of Hansa Textilchemie it entered the silicone business, which was further expanded in 2010 with the acquisition of Alpina Technische Produkte GmbH and in 2017 with the acquisition of the US-American ICM Silicones Group to serve the rapidly growing market for smartphones, e-mobility, etc. with silicone elastomers. In 2015, CHT acquired the Brazilian company Quimipel Indústria Química Ltda. enabling significant growth of its existing paper business. In 2019, it added sustainable wax additives to its construction business with the acquisition of keimadditec surface GmbH, supporting its vision to be the leading global reference for sustainable chemistry.

This broad diversification has enabled the medium-sized global player for specialty chemicals to avoid being set back by the various crises. CHT customers appreciate above all that CHT responds specifically to their wishes and needs in all areas of application. Particular attention is paid to the development of problem solutions that are characterized by a high degree of environmental awareness, because sustainability plays a major role at CHT. One example is BIOLAY, a newly developed natural barrier product against fats and oils that is readily biodegradable and free from microplastics and fluorocarbons. CHT has implemented the principles of the circular economy in ARRISTAN rAIR, a hydrophilic agent made from recycled PET bottles for long-lasting moisture management effects in sports and active wear made from recycled yarns and fabrics.

CHT aims to contribute to a sustainable future with its chemical products and solutions and to offer added value to customers. In addition, climate protection and meeting the goal of keeping global warming to 1.5 °C are important future tasks for mankind and, at the same time, a major challenge for medium-sized chemical companies. CHT is leading the way in contributing its share.

About the CHT Group

The CHT Group is a medium-sized global player for specialty chemicals and active worldwide in development, production and sales. CHT Germany GmbH in Tübingen is the headquarters of the group of companies which focuses on sustainable chemical products and process solutions.
TEXTILE SOLUTIONS of CHT improve the quality, functionality as well as look and purity of textiles and optimize their manufacturing processes.

In the fields of silicones, building materials, paints, coatings, leather, release agents, paper, agrochemicals, mining as well as cleaning and care products innovative products and process solutions are provided by INDUSTRY SOLUTIONS.
By combining the strengths of the complete group further innovative products, applications or processes are continually developed and vast technical support is offered within the SCIENCE & SERVICE SOLUTIONS. Highly qualified specialists work in state-of-the art laboratories for development, analytics and application technique in order to work out ideas and solutions that meet the latest requirements.

The CHT Group with its own production and sales locations is represented by 27 companies worldwide. In the financial year 2022, the CHT Group generated a group turnover of 705 million Euro with around 2,400 employees. In 2023, CHT celebrates its seventieth anniversary. Let's celebrate seventy years of Smart Chemistry with Character!

For more information, please visit:
www.cht.com

Prof. M. D. TELI Endowment Inaugural Oration - 2023 delivered by Padma Vibhushan Prof. M. M. Sharma, FRS

On Friday 14th July, 2023, the day started with heavy rains, which continued till 12 noon causing the anxiety in the minds of a group of few people at ICT involved in arrangements of a special Function i.e. Inaugural Oration under Prof. M. D. Teli Endowment, to be held in KV Auditorium of Institute of Chemical Technology (ICT), Mumbai. The speaker was none other than Padma Vibhushan Prof. M. M. Sharma, FRS and Former Director of ICT/UDCT.

However, in the afternoon the sky was much kindlier, rains were receded, and by 5.30 pm sharp when the programme started, the Auditorium was packed to its full capacity. Every one was amazed to see such an overwhelming response to this Endowment lecture, and cum what may, all the esteemed invitee's majority of them being at the helm of affairs of their companies, industrialists and senior academicians made it convenient to personally be present to this function. Thanks to the good follow-up of the organizers, the Department of Fibres and Textile Processing Technology (DFTPT) and the special love and affection cherished by the participants towards Prof. M. D. Teli in whose name this endowment was established by his past students and well-wishers, a unique example in ICT. The icing on the cake of this function was special attraction and respect Padma Vibhushan Prof. M. M. Sharma commands in the audience. He said that he made an exception to give this Endowment lecture, merely because he carried a special love and respect to the dedicated services of Mangesh (Prof. M. D. Teli) and his achievements.

After lighting the lamp at the hands of Prof. Teli, Prof. Sharma, Prof. Pandit, Prof. Kale, Prof. Adivarekar and Prof. Athalye, the program started with "Vidyapeeth Geet". Prof. R. D. Kale who is the Head of the Department of Fibres and Textile Processing Technology, ICT, then narrated some personal experiences about Prof. Teli and said how meticulously he would guide the students not only in research, but also in their personality development and communication skills. He said, during his period, the Textile Department in ICT became famous at National and International platforms as Prof. Teli did not spare a single opportunity to participate actively in various events and acted as its Brand Ambassador.

Then followed the comprehensive introduction of Prof. M. D. Teli and the newly established Endowment, by Prof. R. V. Adivarekar, the Dean (HRD), ICT and also former Head, DFTPT. Some of the highlights of the achievements of Prof. Teli included: he being 3 times the top ranker in B.Sc. (Tech.) and M.Sc. (Tech.), in the University; served 10 years as HOD, DFTPT and as a Dean, Students affairs and HRD for another decade; also served as Member of Board of Governors of ICT. Honoured with Textile Ratna award, Honorary Fellow of Textile Association, Fellow of Maharashtra Academy of Science, Academic Excellence award for distinguished services to Textile Education, Research and Textile Industry; Acted as Sole evaluator of TUFS (1st Phase) of about Rs. 25000 Crore, from Government of India and Co-ordinator of Rs. 33.33 Crore World Bank assisted TEQIP at ICT which topped the list in best performing programmes run in the Country, etc.; had been Technical consultant to many MNCs and companies in India; visited more than 25 universities abroad and presented his research work in conferences; guided 150 research students including 35 of them Ph.D. (Tech.)/Ph.D. (Sci);

Published 350 Research papers including 200 in International Journals; edited 29 Books; authored 6 Book Chapters; obtained 5 Patents; served almost all Textile Research Associations in India such as ATIRA, BTRA, MANTRA, SITRA, CSTRI as either their Chairman or member of Research Advisory Committees. Presently he is serving Co-Chairman, SITEX (DRDO), Chairman CSTRI and expert for ASCI. As co-curricular activities Prof. Teli has been also serving on Board of Trustee of Bahai Lotus Temple, and Bahai Academy which is actively serving the University Teachers and Students of a number of Universities in Maharashtra in the field of Education in Universal Human Values.

Due to his strong belief in "Vasudhaiva Kuttumbkkam", World is one family right from beginning of his academic career, Prof. Teli assisted every student who crossed his path in terms of financial assistance, moral support in times of their distress or personal guidance about their career path, etc. He treated all his research students as his own family members and thus Prof. Adivarekar, mentioned that legacy of such inspiring teacher had to be continued in ICT. It is for this reason he and his friend, the First Ph.D. (Tech.) student of Prof. Teli, Dr. N. M. Prasad, Director of Chemistar Intermediates Pvt. Ltd., Ahmedabad, decided to establish Prof. M. D. Teli Endowment and this idea

was delightfully accepted by Prof. A. B. Pandit, Honb'le Vice Chancellor of ICT. Prof. Teli was amongst a few initial contributors to this Endowment and subsequently they approached other students including the well-wishers. As it is understood this Corpus is open for Donations from people who liked to donate to this Cause, and Donations qualify 100 % Tax exemption. Needless to mention that Interest income of this Corpus fund is going to be used for financially assisting needy but deserving students of ICT.

Subsequently Prof. Pandit in brief said that since Prof. Adivarekar had given complete background of this endowment, and due to paucity of the time he would like the time to be devoted to listening to the talk of Padma Vibhushan Prof. M. M. Sharma. He said Prof. Sharma makes himself increasingly available for sharing his knowledge and that is the hall mark of a true teacher.

Prof. Sharma, appreciated the dedicated service of Prof. Teli to ICT and unique gesture shown by his students, by founding an Endowment in the name of their Teacher. He said he has made an exception to talk in ICT for an Endowment lecture and it was because Prof. Teli approached him to give the same. The topic was also suggested by him.

The Oration of Prof. Sharma on the subject "Sustainability-A boon or bane?" started by his comment that it has been indeed a Boon. He split the subject in water, energy and raw materials. 70% of water goes into agriculture, and it is consumed more by rice and sugarcane production. He said that there is no water balance in rice and sugarcane production. In addition, there is a new band wagon to convert cane juice in to alcohol to be used as a fuel. Not being in conformity with this approach he asked the audience as to how fare is it converting a food item to the fuel, and whether it is proper. Rather we should use bagasse which is a grow waste and if we are able to get a breakthrough technology to covert this cellulosic raw material into alcohol, that will be a more sustainable approach. Coming to cotton textile processing which consumes large amount of water not only in production of cotton but also in processing, he said it's time to think of limiting the use of water in cotton textile processing, for saving precious water and also reducing effluent treatment load. Water recycling and water harvesting are complimentary to sustainability objectives. In arid areas one could also think of capturing water form moisture in air using adsorptive technology. In chemical industries and Textile processing, Zero discharge is indeed now becoming a new norm. Should we follow the age old water intensive Xanthation process or should we shift to solvent aided process which is more benign? Thanks to the birth of adsorptive technology and it is already developed.

Chemical Technologist and Chemical Engineers have increasing opportunities due to enforcement of Sustainability. Coming to the organic chemistry field, he said most of the earlier chemicals were made from renewable raw material like alcohol. First polyethylene plants were based on alcohol. The first NH3 plant was based on electrolytic hydrogen. We have forgotten these old technologies, but they make quite sense in present conditions as processes based on electrons are benign and require very little energy. So when bane becomes a boon is when waste products are converted as raw materials for newer processes to get value added products.

There was a time, associated gases were burnt in the refineries, which contained Methane, Ethane and H2S. India was dependent on mined Sulphur. But now we are having surplus Sulphur due to the efficient Sulphur recovery plants based in oil refineries. Thus H2S which was considered to be a curse and a bane, now it has become a boon. Similarly, Coal ash is being now used in Cement sector. One can use Coal ash in Zeolites. Phospho gypsum being used in Cement plant and thus this Phospho gypsum otherwise would have been liability in the phosphoric acid plants which is converted into wealth.

Recyclability of polyester is almost established in water bottles' case. One can think of apparels recycling based on polyester, as it also used less amount of water in processing as compared to cotton. India has no Cobalt, no Nickel, no Iridium, no Lithium and under these circumstances one should think of sustainability of Solar energy as majority of the Solar Panels components are imported in the country. However, wind energy can be helpful. We can place these poles offshore, but we should be able to manufacture 200 m length blades.

Thus by a number of examples Prof. Sharma by saying why Sustainability is a boon rather than bane, and how it provides impetus for scientists to explore newer Technologies.

Then followed presentation of Memento to Prof. Sharma at the hands of Honb'le Vice Chancellor Prof. A. B. Pandit and Prof. M. D. Teli.

Dr. Kedar Kulkarni proposed the Vote of Thanks. The function concluded with refreshment.

In all, it was indeed a very befitting function and participants were happy attending the same.

RIETER

Ad-hoc announcement pursuant to Art. 53 LR

First Half of 2023

- Sales significantly increased to CHF 758.2 million
- Order intake of CHF 325.0 million; order backlog of around CHF 1 100 million as of June 30, 2023
- EBIT of CHF 25.2 million and net profit of CHF 13.3 million
- Sale of land in Winterthur
- "Next Level" performance program planned
- Outlook In the first half of 2023,

Rieter recorded a significant increase in sales of 22.2% to CHF 758.2 million, despite some cancellations or postponements of deliveries as a result of the earthquake in Türkiye. Cyclical market downturns in the individual market segments, which were already apparent in the second half of 2022, led to an order intake of CHF 325.0 million (-62.6%) in the reporting period, lower than in the corresponding period of the previous year.

At the EBIT level, Rieter posted a profit of CHF 25.2 million in the first half of 2023, compared with a loss of CHF -10.2 million in the same period of the previous year. This positive result is attributable to the increased sales and higher gross profit as a percentage of sales of 23.9% (first half of 2022: 21.0%).

The Group is planning a "Next Level" performance program aimed at strengthening sales excellence, sharpening customer focus, improving cost efficiency in production and optimizing fixed cost structures. By taking these measures, Rieter intends to create the basis for providing an even more agile response to the cyclical machinery business. The initiatives planned in this context are expected to incur one-off restructuring costs of around CHF 45 to 50 million in the second half of 2023.

Sales

In the first half of 2023, Rieter posted sales of CHF 758.2 million (first half of 2022: CHF 620.6 million). This corresponds to an increase of 22.2%, despite the fact that deliveries for Türkiye had to be postponed or cancelled, mainly in the Business Group Machines & Systems.

Order Intake and Order Backlog

Order intake in the first half of 2023 was CHF 325.0 million (first half of 2022: CHF 869.4 million). As expected, demand thus weakened significantly from the high level of the corresponding previous year period.

Order intake in almost all regions was characterized by the reluctance to invest in new machines. Only in China did order intake increase due to investments by spinning mills in improving their local competitiveness. In addition, some customers held back pending investment decisions and waited for the innovations presented at ITMA in Milan in June 2023. At the same time, demand for consumables, wear & tear and spare parts declined due to the global market downturn.

On June 30, 2023, the company had a high order backlog of around CHF 1 100 million (June 30, 2022: around CHF 2 100 million). This therefore extends into the year 2024. As in the previous year, cancellations in the reporting period were around 5% of the order backlog, also impacted by the effects of the severe earthquake in Türkiye.

EBIT, Net Profit and Free Cash Flow

In the first half of 2023, Rieter posted a profit of CHF 25.2 million at the EBIT level, with an EBIT margin of 3.3% (first half of 2022: loss of CHF -10.2 million) and a net profit of CHF 13.3 million (first half of 2022: loss of CHF -25.2 million).

Free cash flow in the first half of 2023 was CHF 10.0 million (first half of 2022: CHF -57.1 million), which reflected the positive trend in operating profit. Net working capital remained at a high level.

"Next Level" performance program planned

The challenging market situation over the past two years was marked by severe disruptions in the global supply chain in conjunction with rising material, energy, labor, and production costs. The current global demand for textile products remains at a low level. To increase long-term value for customers, employees, and shareholders, Rieter, as technology leader, is planning a performance program called "Next Level".

The goal of the program is to strengthen sales excellence, sharpen customer focus, improve cost efficiency in production and optimize fixed cost structures. The one-time cost of the program is anticipated to be around CHF 45 to 50 million, which will have an impact on the second half of 2023. Most of the program initiatives will be implemented before the end of 2023 with a view to achieving an expected impact from as early as 2024. With these measures Rieter is aiming to reduce operating costs by some CHF 80 million per year.

The program includes provisions for the net reduction of around 300 positions throughout the Group in relation to overhead functions. The possibility of further market- and volume-related adjustments in the order of 400 to 600 positions cannot be excluded. At the end of June 2023, Rieter had a global workforce of 5 555 employees.

The consultation processes with the employee representatives are expected to begin in the near future. Rieter will provide information about the outcome at the appropriate time.

The Rieter Board of Directors and the Group Executive Committee are confident that the planned strategic and operational measures will lay the foundations for the profitable and sustainable development of the Group.

Rieter site, Winterthur
As communicated on July 10, 2023, Rieter sold the land at Klosterstrasse in Winterthur (Switzerland), which was no longer required for operations, to the company Allreal, Glattpark (Switzerland). The company is acquiring the land with a total area of around 75 000 m2. The agreed sales price is CHF 96.0 million. Transfer of ownership is expected to take place in the fall of 2023 after fulfillment of the legally and contractually stipulated completion conditions. Rieter anticipates a positive impact on EBIT of around CHF 70 to 75 million. The new Rieter CAMPUS is not part of this transaction.

Syndicated loan
The Rieter Group has transferred the bilaterally committed credit lines in the amount of CHF 250 million into a syndicated loan in the same amount. With this transaction, Rieter sustainably strengthens its financing security. The term of the loan is three years.

ITMA 2023
The textile exhibition ITMA in Milan in June 2023 was a resounding success for Rieter. The company showcased innovations in ring and air-jet spinning, as well as in fiber and spinning preparation. The products for increased automation and digitization of spinning mills and solutions in the area of recycling and sustainability were also very well received by customers. The reservation lists for all new machines were fully booked within a few days.

Outlook given the economic situation and the ongoing cyclical market weakness, Rieter continues to expect below-average demand for new equipment in the coming months. A revival is not expected until the fourth quarter of 2023 at the earliest. Rieter also believes that demand for consumables, wear & tear and spare parts will not recover until later in 2023. For the full year 2023,

Rieter expects an EBIT margin of around 5 to 7% (including positive special effects of less than 2%) and sales at the previous year's level of around CHF 1.5 billion.

Presentation Material
The semi-annual report 2023, the media- and investor presentation as well as the media release can be found at: www.rieter.com/media/media-kit/
Forthcoming Dates

- Investor Update 2023 : October 20, 2023
- Publication of sales 2023 : January 24, 2024
- Deadline for proposals regarding the agenda of the Annual General Meeting : February 23, 2024
- Results press conference 2024 : March 13, 2024
- Annual General Meeting 2024 : April 17, 2024
- Semi-Annual Report 2024 : July 18, 2024
- Investor Update 2024 : October 23, 2024

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Bluesign Technologies AG (Switzerland) partners with Diagonal Consulting (India)

Bluesign Technologies AG (Switzerland) partners with Diagonal Consulting (India) to Present "Intexcon 2023" – A Global Denims Summit themed on "INNOVISION".

Bluesign Technologies AG, a global leader in sustainable textile solutions from Switzerland, is proud to announce its partnership with Diagonal Consulting (India) to host the highly anticipated Global Denim Summit on October 3-4, 2023, in Ahmedabad, India.

The Two Day Global Denim Summit serves as a pivotal platform for industry leaders, innovators, and stakeholders to converge and deliberate on wide range of topics including circular denim production, eco-friendly dyeing techniques, consumer awareness, technology developments, global trends and much more. With sustainability at the forefront of their mission, Bluesign Technologies AG and Diagonal Consulting (India) aim to foster dialogue, share insights, and promote actionable strategies to drive positive change within the textile industry. The event is being chaired by Dr. PR Roy, a doyen in textile industry and the "Father of Denims" in India.

"We are excited to join hands with Diagonal Consulting (India) in organizing the Global Denim Summit," aid Katharina Verena Mayer, Regional CRM, Indian sub-continent, at Bluesign Technologies AG". This event underscores our commitment to promoting sustainable practices throughout the denim value chain, driving innovation, and shaping a more responsible & resilient industry."

"We believe that collaboration is essential for the denim industry to move towards a more sustainable future," remarked Nirav Shah, Co-Founder & Partner at Diagonal Consulting (India). "By bringing together global players and stakeholders, the Global Denim Summit aims to ignite meaningful conversations and inspire impactful actions."

For more information on key topics deliberated, registration and sponsorship opportunities
please visit www.intexcon.in

Bluesign Technologies AG:
The bluesign® SYSTEM eliminates harmful substances

right from the beginning of the manufacturing process as well as sets and controls standards for an environmentally friendly and safe production. The bluesign® SYSTEM has been adopted worldwide by Textile, Chemical, Machine & Accessory Industry. Well-known brands in the outdoor, sportswear, and fashion industry rely on the extensive knowledge that bluesign provides.

Diagonal Consulting (India):
Diagonal Consulting is a leading consulting firm, specializing in Textile value chain. Focused on Sustainability and Innovation, Diagonal Consulting (India) offers comprehensive strategic management & project consulting solutions for the industry to be globally competitive.

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Lenzing expands REFIBRA technology to LENZING ECOVERO

Lenzing expands REFIBRA™ technology to LENZING™ ECOVERO™, setting new responsible viscose standards for textile circularity

Lenzing provides new solution to combat global textile waste by expanding the eco-efficient REFIBRA™ technology to LENZING™ ECOVERO™ branded viscose fibers Available worldwide, LENZING™ ECOVERO™ with REFIBRA™ technology features up to 20% of recycled raw material content from post-consumer textile waste, with an aim to increase the ratio in the future. The new offering empowers value chain partners to join forces with Lenzing to accelerate the transition to a circular textile economy

Lenzing Group, a world-leading producer of wood-based specialty fibers, has launched LENZING™ ECOVERO™ with REFIBRA™ technology at this year's Intertextile Shanghai Apparel Textile Fair and Trade Show. Building on the success of TENCEL™ Lyocell fibers with REFIBRA™ technology, the expansion of the REFIBRA™ technology to LENZING™ ECOVERO™ will help Lenzing increase the overall post-consumer content in its products. The expansion further highlights Lenzing's ongoing stride towards the transition to a circular economy in textile and fashion with its innovative, future-proof solutions.

“As climate change compels eco-conscious living, Lenzing collaborates with the industry to forge a future defined by collective engagement and systematic change, steering us toward a circular economy,” said Florian Heubrandner, Executive Vice President Global Textiles Business at Lenzing. “LENZING™ ECOVERO™ with REFIBRA™ technology is well-positioned to meet the surging demand for diverse circular design innovations. This new offering empowers like-minded fabric mills, garment manufacturers and consumer brands to embark on this transformative journey alongside Lenzing – breathing new life into post-consumer textile waste while anchoring circularity at the core of the textile value chain.”

Scaling circular responsible viscose fiber production for global textile market
Through Lenzing's successful development and scaled production, LENZING™ ECOVERO™ with REFIBRA™ technology is now available to customers worldwide. Maintaining the eco-responsible benefits of the original LENZING™ ECOVERO™, the new viscose fiber with REFIBRA™ technology comprises up to 20% of post-consumer textile waste, which is sourced from cellulose-rich materials or polyester-cotton blends. The waste is collected and sorted in collaboration with key industry and innovation leaders who champion post-consumer textile recycling programs.

Unleashing unlimited product possibilities with circular solutions
Driven by its “Better Growth” strategy, Lenzing consistently embraces circularity in textiles and empowers itself and its value chain partners to drive systemic change for a greener future. LENZING™ ECOVERO™ with REFIBRA™ technology plays a crucial role in this vision, filling the gaps for mills, manufacturers, and brands that seek to meet evolving industry requirements and consumer preferences globally.

This new fiber is identifiable at every stage of the supply chain, from fabric to final product, ensuring traceability and transparency. This empowers brands and retailers to offer genuine products while enabling consumers to make informed purchases.

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KARL MAYER GROUP

Mastering a Hairy Affair

Cooperation to unlock the potential of merino wool for knitwear

The KARL MAYER GROUP, the Südwolle Group and another player in the natural fibres sector have joined forces in a project to explore the exciting possibilities of merino wool for warp knitting technology. The project was triggered by the increasing market demand for textiles made from sustainable and environmentally friendly materials. The cooperation was to develop innovative fabrics from renewable raw materials for use in underwear and functional sportswear. The focus of the work was on the use of wool as a material with excellent comfort properties and the look and feel of lightweight single jersey goods. The natural fiber fabric qualities are not typical for warp knitting processing, so the challenges during the project work were diverse.

Merino wool yarns with good running properties

Regarding the choice of material, the product development team of Südwolle Group recommended the Hidalgo yarn from their product portfolio. The yarn was created using the in-house developed Betaspun technology, in which a filament was twisted around a merino core. When natural fibres such as wool, cotton or silk are combined with sustainable fibres such as biodegradable polyamide as the filament, the spinning process can create durable, lightweight yarns that disintegrate completely without residue after use. The yarns made from the two components also have good running properties for use in warp knitting. "The polyamide content of the yarn increases its tenacity, reduces hairiness and makes it an excellent choice for warp knitting technology," confirmed Gabriela Schellner from KARL MAYER's Textile Product Development Department.

Shape stability paired with single jersey "look and feel"

The Hidalgo yarn, which is made from merino wool, was processed on a warp knitting machine using a carefully thought-out lapping selection to produce a light, soft fabric which, above all, retains its shape. The textile specialists at KARL MAYER had experimented with two different single bar fabric qualities beforehand and had thus adopted a new approach for jersey machines.

The foundation stone is laid

The first results are promising. "The best thing about the project was the positive surprise of our experts about the good running properties and the excellent fabric quality," confirmed a member of Gabriela Schellner's team. Now more trials are needed to perfect the technique. Development partners are needed, including fabric producers, brands, and garment manufacturers, with whom the fabric qualities, machine equipment and orientation to the end applications can be refined.

The KARL MAYER GROUP and the Südwolle Group are also unanimous in their desire to push the boundaries of what is possible with merino wool and knitting technology and to develop exciting new solutions for the textile industry through further project work.

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Gabriela Schellner

Warp knitted fabrics made from the Hidalgo yar

Warp knitted fabrics made from the Hidalgo yarn

Warp knitted fabrics made from the Hidalgo yarn

STOLL by KARL MAYER

Sophisticated solutions for even more customer benefit

STOLL launches a new innovation package

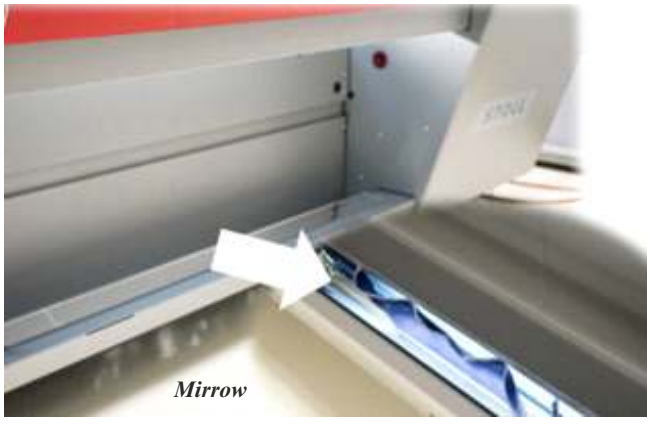
ITMA 2023 was an immensely successful platform for the flat knitting machine manufacturer STOLL to present its latest new developments. The business unit of the KARL MAYER GROUP will be following up this mega fair on 3 July with the launch of a further innovation package. With the

Central Lubrication

solutions contained in this package, STOLL will be offering its customer's additional added value when using their flat knitting machines - in line with the concept of bundling innovations.

The new features include an optimised central lubrication system that reduces both maintenance effort and oil consumption, this as standard from July 2023 for all models of the CMS and ADF series produced in Reutlingen.

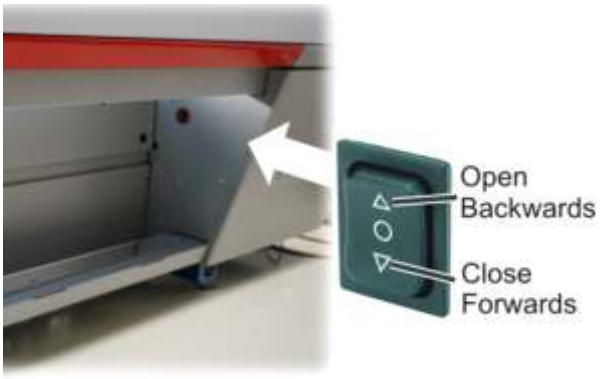
Compared to the previous optional variant, it ensures more efficient and comprehensive lubrication. All needle bed elements, from the holding-down jack to the coupling part and intermediate slider to the selection jack, are now supplied with oil. The machine itself recognises whether lubrication is



Mirrow

required. Independently of this, the lubrication intensity and oil distribution can be adapted to the individual machine conditions by setting various parameters, if required. To ensure that the required amount of lubricant is reliably supplied, a message is sent if the level is too low.

In addition, a new oil drain container as standard equipment for all CMS and ADF models catches used oil from the needle bed under the machine. This prevents soiling of floors or knitted fabrics. The emptying of the container can be efficiently managed by an adjustable reminder function. The neat and at the same time sustainable solution does not require cleaning agents or hoovers and offers the possibility



Switch

to reuse the oil after cleaning through special filters, if necessary.

Mirrow

Users of CMS and ADF belt take-down machines can benefit from optimisations around the belt take-down. Thanks to the new STOLL innovation package, this can be turned forwards and backwards by means of a switch as standard in order to easily eliminate fabric wraps and thus reduce maintenance times. In addition, a mirror, which is also fitted as standard, ensures a simple visual check of the belt take-down.

Another solution of the STOLL innovation package from July 2023 includes new cams that enable split-stitch implementation without cam box modification.

This reduces manual effort and thus conversion times and costs. The feature is standard on all fine gauges ADF and CMS machines.

For the W machines from STOLL, there is now a further inlay yarn carrier, the Qt, in addition to the previous Qw yarn carrier. The extension means that the number of inlay yarn carriers used in a system can be increased from the previous one to three. No additional system is required for the weft yarn, and the process steps weft yarn insertion and knitting take place in the same system.

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TRÜTZSCHLER Textile Recycling: Trützschler and Balkan join forces

The cooperation with Balkan Textile Machinery. INC.CO completes our product portfolio for recycling by cutting and pulling solutions, making us the first full-liner in spinning preparation for recycling! Thanks to our combined machinery expertise and technological know-how our customers can produce yarns at the highest possible quality level – and literally turn waste into value.

We are happy to introduce Balkan Textile Machinery. INC.CO, a partner that not only complements our product line but also shares our values. Both Balkan and Trützschler

Markus Wurster, Director Sales and Marketing at Trützschler Group (left), and Osman Balkan, Owner of Balkan Textile Machinery INC. CO (right)

are family-owned companies for whom sustainability in the textile chain is a major concern. Balkan is well established in Turkey, one of the most important markets for textile recycling. Their robust and reliable machines help to cut, mix and tear textile waste to individual fibers, and to press them into bales of secondary fibers. These bales can be fed to the preparation process with Trützschler machines.

“We are now able to provide a complete line-up of technologically leading machinery which has been specifically developed for rotor and ring yarns from recycled materials”, says Markus Wurster, Director Sales and Marketing at Trützschler Group. “Customers benefit from less complexity when planning and executing a mill project. The combined processes from Trützschler and Balkan are perfectly fine-tuned, reliable and reproducible. And of course, customers have access to Trützschler's premium service.” Osman Balkan, Owner of Balkan Textile Machinery. INC.CO, adds: “I am very happy that we can join forces with such a strong international player like Trützschler. Together we can make a significant contribution to dealing with textile waste globally."

Processing secondary fibers with appropriate card clothing

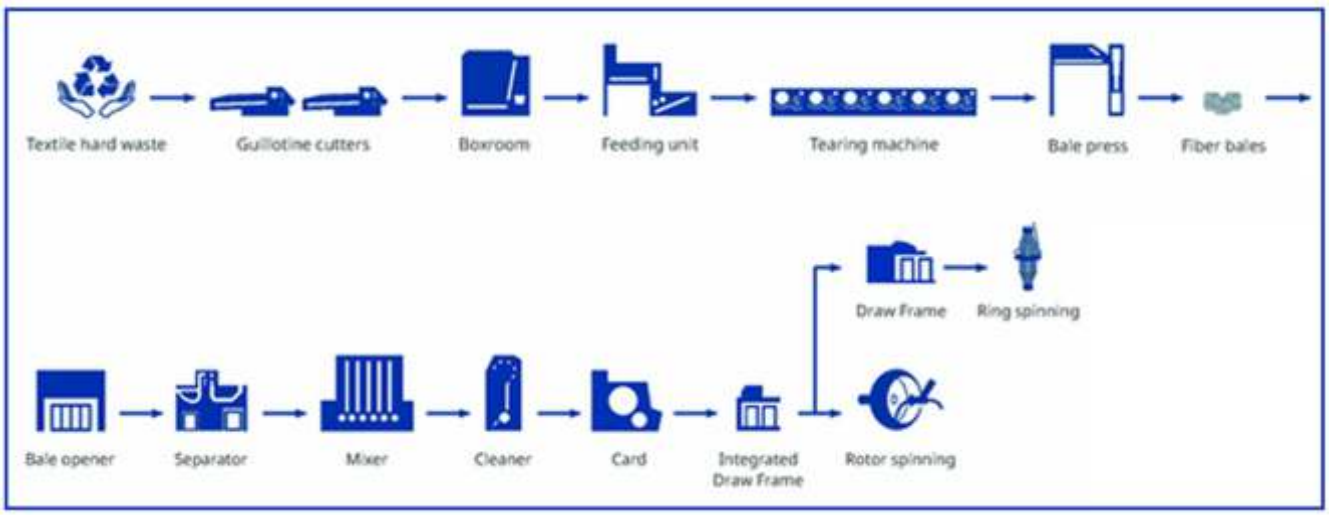
Of course, appropriate card clothing is part of our complete recycling solution. Trützschler Card Clothing continuously developed their card clothing to meet the technological challenges in the processing of secondary fibers and to improve the resulting yarn quality. Special attention has been paid to the flat top as the heart of the carding process. Trützschler Card Clothing has combined the strength of MT/PT 40 and the cleaning power of MT/PT 45, resulting in

MT/PT 45R flat top for recycling

the development of the MT/PT 45R – the new flat top for recycled materials. The right combination of flat top and cylinder wire is the key for yarn quality. Therefore, Trützschler Card Clothing offers various cylinder wires suitable for different recycling applications depending on production rates, type of textile waste and raw material – pure or blends. Thanks to this specification, customers can benefit from the best possible carding result, long lifetime of wires and high production in recycling applications.

"We are excited to offer our customers globally a complete package for recycling from June 2023 onwards”, says Markus Wurster, “including tearing line, blow room, card, draw frame, card clothing and of course our service and technological know-how.”

TRUECYCLED stands for state-of-the art recycling installations from Trützschler. These Trützschler preparation processes enable manufacturers to achieve a high-quality end-product from hard waste. With TRUECYCLED, manufacturers can rest assured they use the best technology and a reliable and reproducible manufacturing process – the pre-requisite for high-quality yarn made from hard textile waste. How does a TRUECYCLED process look like? It is based on Trützschler's technological recommendations and a Trützschler machinery line-up to ensure ideal results from



FIBRESFrom waste to value: Balkan and Trützschler process for the recycling of hard textile waste

recycled materials. For example, Trützschler recently worked with a fashion company to make use of their own pre-consumer waste. Thanks to a special combination of Trützschler blow room machinery, the usage of TC 19i for Recycling and Trützschler draw frames, it was possible to create a ring yarn containing 60 % of pre-consumer waste – a true TRUECYCLED product! Trützschler customers and partners may use the brand TRUECYCLED for both the process itself and the end-product, as long as it contains a significant amount of textile waste.

KARL MAYER GROUP

Uniquely flexible and profitable : Weft insertion reinvented

How WEFTTRONIC® II G with ITMA upgrade maximises customer benefits?

At the ITMA 2023 in Milan, KARL MAYER Technical Textiles presented its best-selling model in the weft insertion machine sector, the WEFTTRONIC® II G, with sensational upgrades, thus demonstrating its understanding of the market. "We were able to record a super response. Especially on the first day of the fair, the number of visitors was surprisingly high", Vice President Sales Hagen Lotzmann sums up with satisfaction. The reason for the high visitor interest were innovative machine features: the new VARIO WEFT laying system, a solution for stabilising the edges, monitoring of the weft tension and a central suctioning device. The WEFTTRONIC® II G was shown at ITMA in a working width of 213″, the best-selling working width for the production of geogrids.

More patterning freedom

Above all, VARIO WEFT delighted customers by revolutionising weft patterning. The innovation makes changes of weft pattern extremely simple, fast and flexible. The electronic solution requires no mechanical intervention during threading in and has no limitations in terms of repeat length. In addition, there is considerably less selvedge waste.

The basis for this advantage package is a newly developed patterning principle: Whereas weft carriage and transport chain used to work with a weft insertion according to the desired pattern, now a full threading in is always used. A stop-and-go operation of the transport chain and a new movement curve of the supporting sinker ensure that the yarn is fed according to the pattern. If a weft yarn is to be inserted into the fabric, it is guided to the knitting elements by the circulating transport chain and brought into the engagement area of the slider needles by the supporting sinker. If a free space is to be created in the fabric, the transport chain stops and the supporting sinker dips under the weft yarn. "The flexibility which VARIO WEFT offers in weft patterning is completely new for our customers. In the discussions on this during the ITMA, potentials were discussed and thought processes initiated. We are expecting many new product ideas, and we will be on hand to help our customers implement them," explained Hagen Lotzmann.

Lower costs and environmental impacts

With the elimination of the vacant positions in the transport chain, the waste generated here is also eliminated. In the conventional process, the weft yarns are passed by the empty positions, and the yarn sections running in the direction of work have to be disposed of, with negative effects on costs and the environmental balance. The relative yarn waste is greater the more positions have to be bridged and weft threads inserted, i.e. the more open the grid is. When considering the absolute savings potential, however, the count of weft yarns in the fabric must also be taken into account.

For example, with a weft threading in of 5 full, 10 out, about 61 % less material is needed. This results in about 38,000 EUR less costs and about 256,000 kg less CO2 emissions per

year. In the case of denser grid designs with a threading in of 2 full, 2 out, the material saving is lower at just under 46%, but the absolute annual saving in costs is higher at around 40,000 euros and in CO2 emissions at almost 270,000 kg.

Stable selvedges

Another innovation of the WEFTTRONIC® II G stabilises the fabric selvedges and uses the weft yarn ends for this purpose. The weft yarn ends sticking out at the sides of the mesh selvedges are mechanically and by means of air flow returned to the warp knitting elements and firmly integrated into the mesh structure by means of a stitch.

Due to the thus consolidated fabric ends, the grids can be better fixed during the finishing process - an advantage especially for medium-weight and heavy geotextiles. This allows the shrinkage behaviour of the warp knitted fabric to be adjusted in a controlled manner and its quality to be improved. The consolidated selvedge structures can also open up new areas of application, for example in the fields of slope stabilisation and safety nets.

Controlled yarn tension

To maximise fabric quality, the WEFTTRONIC® II G has been equipped with a weft tension monitoring system. The new solution keeps an eye on every single yarn and triggers actions when threshold values are exceeded or undershot: first a warning, then the machine is stopped.

When resetting to new patterns, the weft tension can be easily adjusted and controlled, thus improving the reproducibility of the product quality. In addition, the tension data can be stored for control and traceability of production orders.

Automatic suction in non-stop operation

A new device for suctioning off selvedge waste, the CSD 600, focuses on increasing machine efficiency. The innovation continuously picks up the weft waste during machine operation and uses operational stops for fully automatic emptying, without any manual intervention. In addition, less electrical energy is required compared to the previous solution with one suction cabinet on each side of the machine. The savings potential is around 8 %.

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Higher productivity. Better quality. Meet the TCO 21!

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