Office of the Principal Scientific Adviser to the Government of India

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IGNITING IDEAS

Innovation for Handicrafts and Handloom Clusters

Technology advisory note for re-premiumization, propagation and preservation of Kashmiri crafts

INTERACTIVE IMAGE

Innovations for Handicrafts and Handloom Clusters

Technology advisory note for re-premiumization, propagation and preservation of Kashmiri crafts

Technology Advisory Note
September 2023

AGNIi Mission
Office of the Principal Scientific Adviser to the Government of India
Conducted in collaboration with Directorate of Handicrafts & Handloom, Kashmir

INTERACTIVE IMAGE

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FOREWORD

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सत्यमेव जयते

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MESSAGE

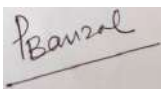
The Office of the Principal Scientific Adviser (PSA) to the Government of India is committed advise and facilitate solving pressing socio-economic challenges with the intervention of science and technology. We believe that Indian technological innovation can, under the aegis of Aatmanirbhar Bharat, help better public service delivery, governance of schemes and welfare of the society.

Office of PSA has a pleasure of working via our AGNIi Mission, with the Government of Jammu and Kashmir, in partnership with the Directorate of Handicrafts and Handloom, Kashmir for overall growth of the handicrafts and handloom industry by employing indigenous innovation ecosystem.

The handicrafts and handloom industry employs more than one crore artisans. The industry creates livelihood by generating indigenous products with significant export potential has implications for India's economic and human development. However, the industry is reeling with challenges posed by the undifferentiated mixing of machine-made products with genuine handmade products, lack of branding and marketing, and low productivity and quality resulting into lower profits and wages for the artisans who engage in hours of physically challenging crafts(wo)manship, and 'languishing' crafts. Directorate of Handicrafts and Handloom, Kashmir's effort with the Office of PSA's support is exploring how technological innovation can help prevent the crafts from getting languished, increase livelihood opportunities with better income, and provide deserved dignity to artisans. Our partnership has identified, assessed, and demonstrated examples of how Indian technological innovation can complement precious artisan work for their welfare and benefitting the ecosystem.

The results of this exercise, captured in the Technology Advisory Note, could support decision-making by public agencies on leveraging such innovation. Further, the initiative can offer important examples for wider emulation across India's handicrafts and handloom clusters.

We warmly appreciate the support and cooperation extended by the Office of the Commissioner Secretary, Department of Industries and Commerce, Jammu and Kashmir, and Directorate of Handicrafts and Handloom, Kashmir, to this effort; and look forward to further progressing this important partnership for the benefit of the artisans in India.



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FOREWORD

Mehmood Ahmad Shah
Director
Handicrafts and Handlooms, Kashmir

Kashmir has long been celebrated for its exquisite, handcrafted products and rich cultural heritage. The Handicrafts and Handlooms sector not only contributes significantly to our economy but also stands as a testament to the artistic prowess of our skilled artisans. Yet, like any living tradition, our crafts must evolve to remain relevant in a rapidly changing world. This is where technology enters the narrative.

In recent years, we have witnessed remarkable advancements in technology that have the potential to redefine the way we approach craftsmanship. From design and production to marketing and distribution, technology offers us an array of tools that can amplify our artisans' abilities and extend the reach of their creations far beyond our borders. This document delves into specific interventions and approaches that can empower us to achieve these goals.

One of the key areas of focus in this document is the convergence of traditional artistry and modern innovation. We explore how digital design platforms can collaborate with our artisans to create new patterns, motifs, and designs while staying rooted in our cultural heritage. Additionally, the integration of technology into the production process is examined, shedding light on how automation and precision machinery can enhance efficiency without compromising the artisan's human touch.

Technology's impact extends to the marketing and distribution of our products. With the advent of e-commerce and digital marketing, we have unprecedented access to global markets, allowing our artisans to showcase their creations to a diverse and appreciative audience. The document highlights strategies to harness these platforms effectively, ensuring that the stories and craftsmanship behind each piece resonate with consumers.

As we embrace these technological interventions, it is imperative that we do so with a delicate balance between innovation and tradition. Our commitment to preserving the authenticity and uniqueness of our crafts should guide technology integration, ensuring that it complements, rather than supplants, the skills and wisdom passed down through generations.

I would like to express my gratitude to the entire team of AGNIi Mission for their unwavering commitment to bringing various experts in technology, Startups and Research Organizations to create interventions captured in this document. Their insights, experiences, and expertise have culminated in a comprehensive guide that I believe will serve as a roadmap for the future of our Handicrafts and Handlooms sector. Let us embrace technology as a catalyst for rejuvenation, a means to honour our heritage while embracing tomorrow's opportunities.

Sincerely,

Mahmood Ahmad Shah,
Director,
Handicrafts and Handlooms, Kashmir.

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PART A | Introduction | Objective and Methods

Innovation for Handicrafts and Handloom

1. This Technology Advisory Note (TAN) focuses on how technology and innovation both emerging and frugal – capabilities for which exist in India's innovation ecosystems, startup, and laboratory – can help transform the handicrafts and handloom industry of India. These innovations include emerging technologies such as, mixed reality solutions, IoT sensors, machine vision, computer vision, as well as frugal innovations from Indian research and development institutes and Rural Technology Action Groups (RuTAGs) at Indian Institute of Technologies (IITs) to enable precise action against the impact of machine-made products on intricate labor-intensive Indian handicrafts and handloom products.
2. The Office of the Principal Scientific Adviser (PSA) to the Government of India, in partnership with national government agencies, identifies and advises on how Indian emerging and frugal technologies can be leveraged to help address national priorities. These priorities include a focus on livelihood creation, and promotion and development of Micro, Small, and Medium Enterprises (MSMEs) that present a significant employment generation potential[1]. The Office's advisory is optimised for relevance, supporting specific decisions; and for execution, providing decision-makers with guidance they can use in the field. This allows Government agencies with a usable basis for drawing on emerging and frugal technology and innovation. By shaping scaled Government engagement with Indian innovation: Office advisory, if executed by agencies concerned, will generate scaled opportunity for Indian startup and laboratory innovation.
3. The TAN summarises guidance developed in collaboration with the Directorate of Handicrafts and Handloom, Kashmir, Government of Jammu and Kashmir, acting as a Pioneer Agency. *Pioneer Agencies* are select organisations within the Government which are mandated to engage these national priorities; in doing so, demonstrate a high degree of proactiveness and progressiveness in their engagement with innovation, technology, and new ideas; and share these priorities with a wider community of similar institutions – allowing scaled impact against these priorities to be assured by the emulation and adaptation of Pioneer Agencies' examples.
4. The guidance in the TAN was developed via Fieldwork, Technology Operational Scenarios, Technology Capability Stacks, Field Immersion Workshop and Technology Showcases.

[1] https://pib.gov.in/PressReleseDetail.aspx?PRID=1628344 (Accessed on August 3, 2023)

a. The Field Immersion Workshop and Field Technology Showcase was held at Srinagar, Jammu and Kashmir. The choice of the showcase site is aligned with the vision of the Directorate of Handicrafts and Handloom, Kashmir, to leverage existing deployable emerging technologies to (re) premiumise, preserve, and propagate Kashmiri crafts and heritage. Additionally, the Directorate is also keen to support research and development for potential customisation of existing, frugal labour complementing innovations to enhance productivity and quality artisans associated with handicrafts and handloom in various craft clusters of Kashmir.

5. Its generating activities undertaken in partnership and consultation with the Directorate of Handicrafts and Handloom, Kashmir, Jammu and Kashmir: the Note and its advice aims to support practical, actionable administrative decision-making on technology engagement and acquisition for transformation of handicrafts and handloom. This in Kashmir – but also in other handicrafts and handloom clusters of India. Aligned to the Government's Aatmanirbhar Bharat priority, the TAN focuses on Indian technological innovation.
6. Equally: The TAN – and the exercises that generate it (technology operational scenarios, stack development, field technology showcases, etc.) – are exercises in change management. They seek to support leadership in driving a wider technology-enabled transformation to improve the populaces' various parameters associated with human development, multi-dimensional poverty, and climate resilience. The analyses and output provide leadership with tools and levers with which to do so.
7. No part of any TAN should be construed as, or be interpreted or derived to generate, support for any individual vendor, startup, innovator, or private actor of any kind. The TAN features specific technologies – whose innovator startups and laboratories volunteered to participate in Field Technology Showcases – merely as examples of broader technological capabilities' existence and readiness within Indian innovation ecosystems, and of how Aatmanirbhar Bharat can be effectively advanced even while supporting key national priorities. At every stage, Government agencies must follow due process under competent authority in engaging, selecting, procuring, and deploying technology.

Scaled Impact: Are TAN and Technologies applicable across the Handicrafts and Handloom clusters of India?

1. Indian handicrafts and handloom are as old as India's first civilization – Indus Valley. They preserve centuries of knowledge, enriched during different phases of history and are a torchbearer of India's rich heritage globally.
2. Impoverished by 200 years of imperialistic economic policies of Great Britain, Indian handicrafts and handloom industry was handicapped at the time of independence. However, the crafts survived and were revived post-independence[2].
3. Presently, India is home to 2, 000+ specialized handicrafts and handloom clusters spread across almost all the states and union territories of India[3]. Each producing a variety of intricate and exquisite products of world-class crafts(wo)manship, an embodiment of hours of eye hurting and back breaking work by artisans across the country.
4. The industry has significant cultural, economic, human development, and international relations implications. However, despite these considerations, the handicrafts and handloom clusters of India are afflicted by myriad similar problems with significant bearings on the artisan community, thus posing an important human development concern.

Choosing Kashmir as an Exemplar

1. Sustenance of peace in Kashmir valley is a key central government priority. A key strategy of the government in this regard has been to facilitate socio-economic development via industry and services sector with special emphasis on employment generation, skill development, and sustainable development[4].
2. With regards to the above, handicrafts and handloom sector is a key priority for the UT administration[5]. Besides, provision of training, design support, infrastructure (physical and financial) support, a key focus area for the administration is to provide a technological thrust to the handicrafts and handloom cluster.
3. In this context, the Directorate of Handicrafts and Handloom, Kashmir, has emerged as an 'Innovator' and is spearheading the technological revolution in the handicrafts and handloom sector of the country.

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[2] Rise of Handloom to a Global Industry | Ministry of Micro, Small & Medium Enterprises (msme.gov.in)

[3] 1,436 handloom clusters & 744 handicraft clusters under Ambedkar Hastashilpa Vikas Yojna; Development Commissioner for Handlooms; 4th All India Handloom Census Report (2019-20); Cluster Directory, Ministry of Textiles; Ministry of Textiles Annual Report 2022-23

[4] https://pib.gov.in/PressReleasePage.aspx?PRID=1686743 (Accessed on May 29, 2023)

[5] https://www.business-standard.com/article/economy-policy/record-growth-in-handicraft-handloom-sector-in-j-k-in-3-months-lg-sinha-123031800926_1.html (Accessed on May 29, 2023)

4. With the interventions of the Directorate of Handicrafts and Handloom, Kashmir, Jammu and Kashmir became the first UT/state in the country to issue Quick Response (QR) based codes for all its crafts[6] both with geographical indication (GI) tag and non-GI[7]. This will provide a strong foundation for re-premiumisation, preservation, and propagation of the UTs rich artistic and cultural heritage. The QR based codes for handicrafts and handloom products could be instrumental in setting up provenance and payment tracking mechanisms in the future to further strengthen processes to limit counterfeits and improve artisan earnings.
5. The handicrafts and handloom sector of Kashmir is also receiving international recognition. In 2021, Srinagar was selected as a 'Creative City' by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) under its Creative City Network. With this Srinagar has entered a coveted list, with only five other Indian cities (Mumbai, Chennai, Hyderabad, Varanasi, and Jaipur)[8]

Fig 1: QR Codes Deployed by the Directorate on various Handicraft Products for Provenance Tracking

[6] https://awaamkibaat.jk.gov.in/lt-governor-launches-qr-code-based-labels-of-13-different-gi-non-gi-registered-crafts-of-jk/ (Accessed on July 18, 2023)

[7] GI: Kani Shawl, Pashmina, Sozni Craft, Papier Mache, Walnut Wood Carving, Khatamband, Hand-knotted carpets; Non GI: Namdah, crewel, chain-stitch, silverware, filigree, copperware, and willow wicker.

[8] https://indianexpress.com/article/explained/srinagar-unesco-creative-city-explained-7614289/ (Accessed on August 3, 2023)

Scalability of TAN across the Handicrafts and Handloom clusters of India

1. Jammu and Kashmir's handicrafts and handloom sector is one of the major and oldest in the country[9]. The twin sectors form an important social and cultural component of the UT and are one of the mainstays of its economy[10]. However, the declining profitability of the sector is an important cause of concern with significant economic and human development implications.
2. Evidence gathered both during AGNIi field visits in Srinagar[11] and via secondary research[12], it emerged that the sectors declining profitability can be primarily attributed to – undifferentiated mixing of cheap machine-made products with original handmade products in the market depressing both prices and wages, lack of mechanisms to check counterfeiting, lack of narrative based branding and marketing that help end buyers realise the products actual worth, low productivity, and quality challenges for example, usage of chemical dyes that impede fetching higher prices in global markets rallying towards sustainability. Further, declining profitability has reduced inter-generational self-employment in these sectors resulting 'languishing crafts', which threatens the very existence of these centuries old crafts – an important symbol of India's cultural heritage.
3. However, declining profitability and resulting languishing crafts are not special to Jammu and Kashmir. Craft clusters across India are united by the above challenges[13]. Report of the Steering Committee on Handlooms and Handicrafts constituted for the Twelfth Five Year Plan (2012-17)[14] put on record the myriad challenges afflicting the sectors subsuming the above-mentioned problems.
4. In this regard, technological interventions both frugal and emerging can be an effective enabler for the handicrafts and handloom sector, something also alluded to by the above-mentioned Planning Commission Report. Technology and innovation can help address various pain points that afflict artisan communities and improve their earning potential. These can be effectively tested in Kashmir as the UT presents a microcosm of the Indian handicrafts and handloom clusters and hence presents a significant scaling potential across Indian clusters (refer Table 1).

[9] Wool Processing, Handloom, Handicrafts Policy 2020, Jammu and Kashmir (Accessed on July 19, 2023);

[10] ibid

[11] December 19-21, 2022. The Mission team interacted both with artisans and officials from the Directorate of Handicrafts and Handloom, Kashmir, and its allied agencies. These include interactions with – School of Design, Craft Development Institute, Pashmina Testing Facility, and artisans in the craft clusters of Narwara, Kathidarwaza, Zadibal, Bagh Ali Mardan Khanin Srinagar

[12] ibid

[13] https://pib.gov.in/newsite/printrelease.aspx?relid=171707 ; Datta and Bhattacharya (2016)

[14] Planning Commission (2012)

Table 1: Scaling Potential of the TAN across India's Handicrafts and Handloom Clusters

#	Pain Points and Technology Use Cases	Scaling Potential[15]
1.	**Pain Points:** Undifferentiated mixing of genuine Kashmiri handicrafts and handloom products with cheap machine-made products and the inability to authenticate handmade Kashmiri crafts from counterfeit machine made products Inability to articulate the narrative behind Kashmiri Handicrafts & Handlooms **Technology use-case:** Verification of authenticity of Kashmiri handicrafts and handloom products	• 1,463 handloom clusters • 744 handicraft clusters under Ambedkar Hastashilpa Vikas Yojna • Number of Handloom workers in India (weavers & other) = 35,22,512 • Artisans employed by the handicrafts sector in India = 68,86,000
2.	**Pain Points:** Languishing heritage, knowledge, and skills of ageing Master artisans **Technology use-case:** Preservation of the skills of Master Artisans Dissemination of knowledge to budding artisans Interactive museum infotainment	
3.	**Pain Points:** Non-modernisation of legacy tools and equipment with productivity and health implications **Technology use-case:** Artisan centric modernisation of the existing machinery (tools and looms)	

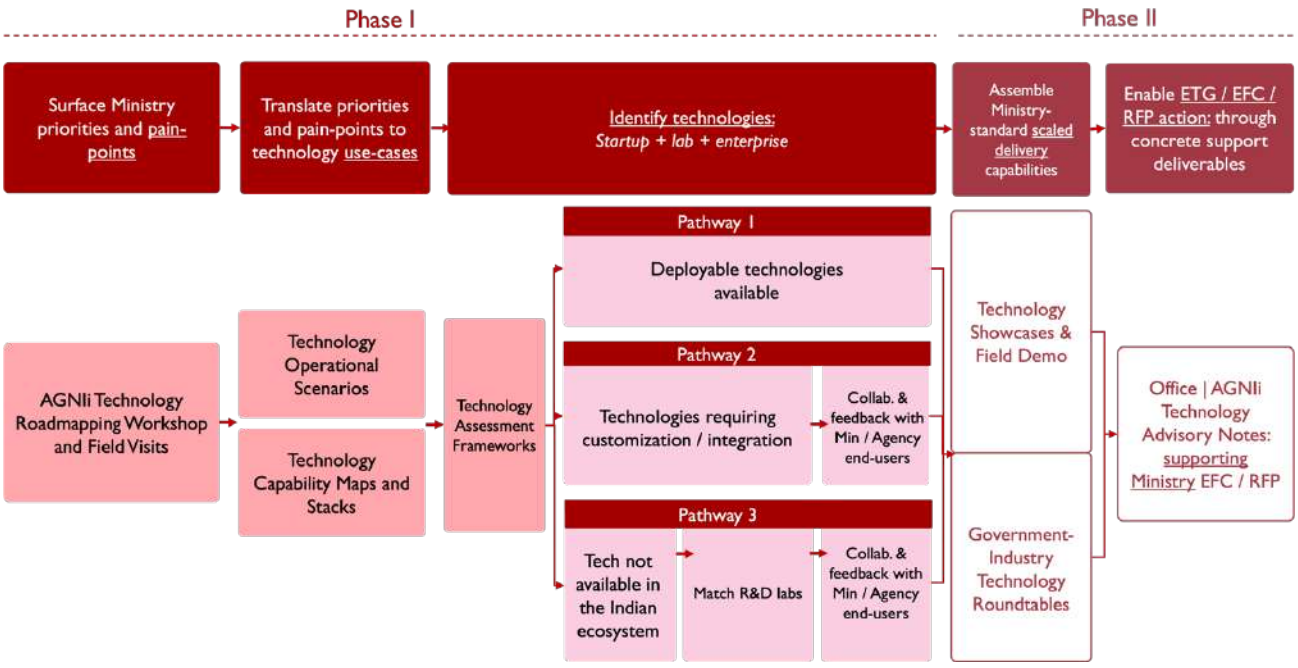
[15] Development Commissioner for Handlooms; 4th All India Handloom Census Report (2019-20); Cluster Directory, Ministry of Textiles [Accessed on August 7, 2023]

#	Pain Points and Technology Use Cases	Scaling Potential[15]
4.	**Pain Points:** Lack of a vibrant natural dyes' palette for pashmina and carpets **Technology use-case:** Development of vegetable based and sustainable material dyes preferably from local flora. Tools for identification and mapping the shades for standardisation of dyes	• 1,463 handloom clusters • Number of Handloom workers in India (weavers & other) = 35,22,512


INTERACTIVE IMAGE

Methodology | Actionable Advice for Scaled Impact: Exemplar Projects

Fig 2: AGNIi Workflow



1. Practicality: Ensuring Technology Decision-Making Support is Actionable. To ensure that agency decision-makers receive technology and innovation advice that is actionable in the field: the Office's AGNIi Mission, under the Prime Minister's Science Technology and Innovation Advisory Council develops this advice through
2. *Exemplar Projects*, executed in collaboration with a *Pioneer Agency*.
    a. *Exemplar Projects* address pain-points identified by senior Government authorities in that sphere as comprising a major and scaled national priority.
    b. *Pioneer Agencies* are select organisations within the Government which
        i. are mandated to engage these national priorities;
        ii. in doing so, demonstrate a high degree of proactiveness and progressiveness in their engagement with innovation, technology, and innovative ideas; and
        iii. share these priorities with a wider community of similar institutions – allowing scaled impact against these priorities to be assured by the emulation and adaptation of Pioneer Agencies' examples.
3. Ensuring Decision-Making Relevance: *Technology Operational Scenarios*. AGNIi targets emerging technology innovation to support agency priorities and requirements, as follows:

a. The Exemplar Project analyses and characterises this pain-point, determining its dimensions and decision-factors:
    i. *Field Level*, which have bearings on artisans, manufacturers and exporters.
    ii. *Operational*, which senior administrative tiers must resolve. This would include the Director, Handicrafts and Handloom, Kashmir and allied agencies like Indian Institute of Carpet Technology, Craft Development Institute, School of Design and Wool Processing Unit.
    iii. *Strategic*, affecting leadership-tier decision-making. This would include the state level leadership (Secretary, Industries and Commerce)
b. To ensure decision-making relevance: AGNIi executes that analysis and characterisation as follows:
    i. *To determine field level and operational decision-making dimensions:* AGNIi team visits to field locations – selected for representing the most challenging circumstances the Pioneer Agency faces – to research and characterise pain-points as they are experienced and determined on the ground.
    ii. *To determine operational and strategic decision-making dimensions:* the AGNIi Mission also consults, via a series of meetings, with Pioneer Agency representatives.

4. Solving Challenges with Technology: *The Technology Stack*. The Project then formulates a 'stack' of emerging technologies – within Indian startup and laboratory capability, demonstrated through specific examples – which can engage these challenges.
    a. Technology Stacks integrate innovation across multiple technologies – for example, emerging technologies such as, mixed reality solutions, IoT sensors, machine vision, computer vision, as well as frugal innovations from Indian research and development institutes and Rural Technology Action Groups (RuTAGs) at Indian Institute of Technologies (IITs)*;*
    b. They position these technologies against operational capabilities required to address the challenges of the handicrafts and handloom sector – for example (re)premiumisation of Kashmiri crafts, enhancement of productivity, improvement of quality, and preservation and propagation of Kashmiri crafts heritage. Where these technologies and capabilities intersect – solutions are identified – for example, mixed reality solutions for creating immersive experiences revolving around a virtual showroom, narrative technologies, digital museums, and metaverse space for providing artisans access to the global markets.
    c. For each of these solutions – examples of concrete Indian innovation are identified, in the form of startup, research and devlopment institutes or laboratory innovation. This offers the agency clarity that Indian innovation is available, under Aatmanirbhar Bharat objectives, to solve its challenges.

i. Crucially, these examples (and the wider TAN) do not recommend or endorse any vendor;

d. These technologies and capabilities are framed in terms of how they work together, to offer workable solutions to the broader operational challenge that the Technology Operational Scenario identifies and characterises.

5. Demonstrating Workability and Options: *Field Technology Showcases*. To demonstrate this innovation's practical potential – actual impact on the ground, for Government decision-makers, against these priorities – the AGNIi team conducts Field Technology Showcases in locations representative of those where these priorities are encountered.

   a. Hosted by the Pioneer Agency, startups, research and development institutes, and laboratories are invited to demonstrate how their innovation resolves these pain-points in the field.

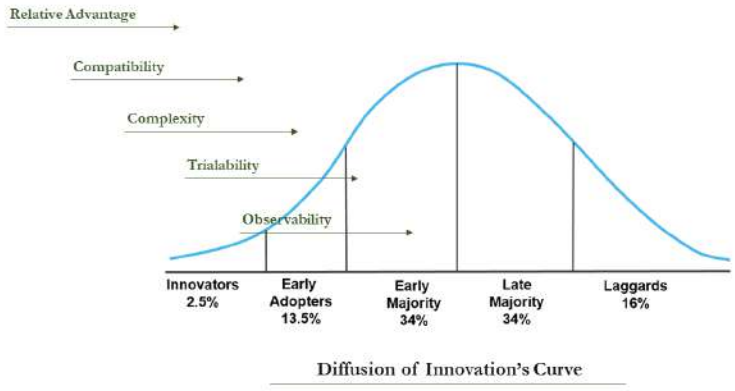
   b. The Showcases generate assessments for decision-makers on whether, and to what extent, innovation in its current form can resolve these pain-points.

   c. The Exemplar Project consequently seek to represent the microcosm of the sphere they are working in. Pioneering Agency, one which deals with the 'microcosm' as a part of their regular functioning.

   d. Importantly: Field Technology Showcases do not substitute technology evaluations conducted as part of the public tender process. Instead, they seek to help agency officers expand decision-making options in their quest to engage key priorities.

   e. Crucially: Field Technology Showcases seek to support the actual adoption of relevant, effective innovation, by activating five crucial levers of innovation diffusion. First identified by innovation scholar Everett Rogers, in his development of the Diffusion of Innovation curve (or Rogers' Curve): these factors, if demonstrated, drive adoption decisions. Each Field Technology Showcase seeks to demonstrate these.

Fig 3: Diffusion of Innovations Curve (The Rogers Curve)



Source: Rogers, E. M. (1962). Diffusion of innovations. New York, Free Press of Glenco.

Fig 4: Field Technology Showcase, Srinagar, Jammu and Kashmir

6. Advice (and supporting analyses) are captured in TANs: supporting specific administrative action to engage and leverage Indian emerging technology within the handicrafts and handloom clusters of Kashmir and across other Indian states facing similar challenges, in fulfilling national priorities at scale.
7. Change Management: Supporting Agencies in Transformation through Innovation. The Office of PSA's key objective, in its collaborations with agencies engage Indian emerging technology and innovation in answering national priorities – through the collaborative model outlined above. This embrace of innovation, with Office support, involves institutional change: with agencies upgrading their organisational capabilities through technology. The AGNIi advisory project cycle described above supports this, activating eight change management levers.

Table 2: Change Management

Step	Change Management Lever	Collaborative Action	AGNIi Technology Advisory Workfllow Phase
Step 1	*Establish and identify urgency*	Leadership consultations: Directorate of Handicrafts and Handloom, Kashmir, Government of Jammu and Kashmir, Indian Institute of Carpet Technology (IICT), School of Design, Craft Development Institute, Craft Museum, Pashmina Testing Facility, Wool Processing Unit Aligning to priorities / guidance / values set by them - Priorities on safeguarding artisans against the proliferation of counterfeit handicrafts and handloom products - Preventing the crafts from getting languished by enabling intergenerational skill transfer -Analysis of existing technology scenario to explore the extent to which mechanization is acceptable	Agency Pain-Point Mapping Workshops / Consultations Field Visits
Step 2	*Form guiding coalition of authority*	Collaboration with leadership and field agencies intersecting operational and tactical interests and urgencies. Develop Technology Operational Scenarios with Directorate of Handicrafts and Handloom, Kashmir.	Agency Pain-Point Mapping Workshops / Consultations Field Visits Technology Operational Scenarios
Step 3	*Collaborate to surface Agency vision*	Develop Technology Operational Scenarios via focus group discussions and key informant interviews conducted among artisans in craft clusters; and stakeholder consultations with Pioneer Agency (Directorate Handicrafts and Handloom, Kashmir), and its allied agencies - Indian Institute of Carpet Technology (IICT), School of Design, Craft Development Institute, Craft Museum, Pashmina Testing Facility, Wool Processing Unit: describing baseline scenarios and target end-state.	Technology Operational Scenarios Technology Stacks Field immersion Workshop and Field Technology Showcases

Step	Change Management Lever	Collaborative Action	AGNIi Technology Advisory Workfllow Phase
		Develop Technology Stacks: reflecting functional requirements generated by Operational Scenarios. Collaborating with Pioneer Agency (Directorate of Handicrafts & Handloom, Kashmir) and its allied agencies - Indian Institute of Carpet Technology (IICT), School of Design, Craft Development Institute, Craft Museum, Pashmina Testing Facility, Wool Processing Unit to implement Field Immersion Workshop and Field Technology Showcases: demonstrating how Indian innovation (representing Stack elements), in realistic field scenarios, delivers target end-state.	
Step 4	*Communicate the vision*	Demonstrate Indian innovation providing solutions – and alternatives to conventional decision-making options – in realistic field scenarios. Showcases demonstrated to -strategic & operational leadership (Secretary – Industries and Commerce, Directorate of Handicrafts and Handloom, Kashmir) - representing solutions answering interests and imperatives across decision-making tiers.	Field Immersion Workshop and Field Technology Showcases
Step 5	*Enable decision-makers to act on that vision*	Evaluation (e.g., via Directorate of Handicrafts and Handloom, Kashmir) of Field Technology Showcases and Field Immersion Workshop: supporting further administrative action. TAN supports scaled action in Kashmir and across other handicrafts and handloom clusters of India.	Field Immersion Workshop Field Technology Showcases Technology Advisory Notes

Step	Change Management Lever	Collaborative Action	AGNIi Technology Advisory Workfllow Phase
Step 6	*Build momentum via successful short-term action*	Advising the stakeholders like Directorate of Handicrafts and Handloom, Kashmir, and its allied agencies for technology pilots.	Field Immersion Workshop Field Technology Showcases Follow up meetings
Step 7	*Consolidate improvements for further change*	Feedback delivered from evaluations to Stack innovators (on product feature sets), Directorate of Handicrafts and Handloom, Kashmir, and AGNIi (on technology functioning vs. Technology Operational Scenarios)	Technology Operational Scenarios Technology Stacks Technology Advisory Notes Field Immersion Workshop and Field Technology Showcases
Step 8	*Support institutionalisation of innovative approaches*	Supporting administrative action	Technology Advisory Notes

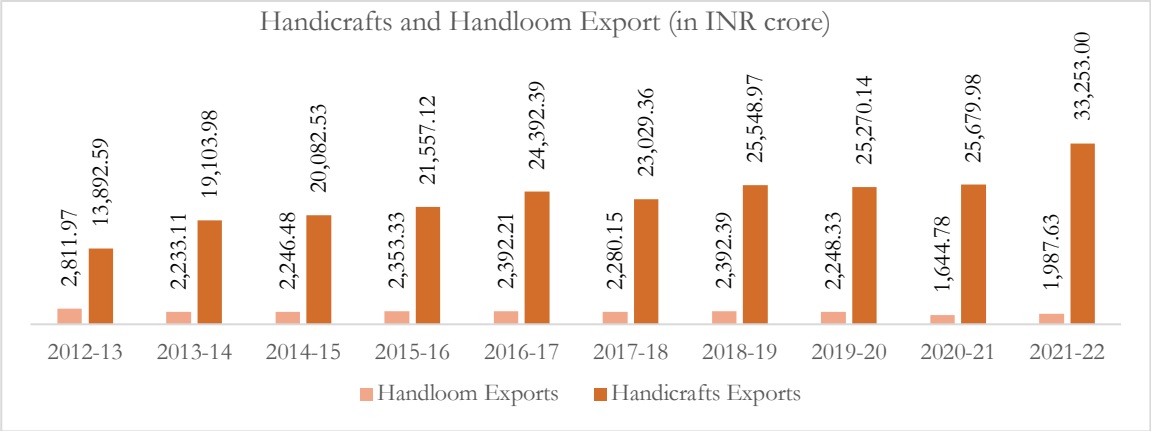

INTERACTIVE IMAGE

Part B | Handicrafts and Handloom Industry

Indian Handicrafts and Handloom Industry

1. The Indian handicrafts and handloom industry epitomises India's regional and cultural diversity and is a symbol of the nation's collective consciousness as exemplified by the Swadeshi Movement of the 1900s or the modern-day clarion call of Vocal for Local.
2. However, the British colonial rule and its imperialistic polices of economic deindustrialization in an era of history characterized by the first industrial revolution, gave a severe blow to India's indigenous handicrafts and handloom industry, which was otherwise the backbone of Indian economy. Thus, leading to the economic disempowerment of India's finest artisan community[16].
3. Post-Independence, considering the economic, human development, social, cultural, and diplomatic implications of the sector, Government of India, has consistently put in place policy and programmatic interventions to revive the handicrafts and handloom industry and is working towards the economic upliftment of the associated artisan community.
4. As such, the handloom industry has emerged as India's largest cottage industry[17] presenting a significant export potential. During 2022-2023, export value of India's handloom products stood at INR 1,446 crore[18]. Similarly, the export value of handicrafts for 2021-22 stood at INR 33,253 crore[19] (refer Fig 5).

Fig 5: Handicrafts and Handloom Exports from India 2012-12/2021-22



Source: Export Promotion Council for Handicrafts[1], Handloom Export Promotion Council[1]

[16] Rise of Handloom to a Global Industry | Ministry of Micro, Small & Medium Enterprises (msme.gov.in)

[17] IBEF (Last accessed on July 24, 2023)

[18] Handloom Export Promotion Council (Last accessed on July 24, 2023)

[19] Export Promotion Council for Handicrafts (Last accessed on July 24, 2023)

5. Further, combined together, the handicrafts and handloom industry employ more than one crore artisan. Around 35,22,512 artisans are associated with the handloom industry as weavers and others. Handloom industry is the second largest employer of citizens after agriculture in the rural areas[20]. Meanwhile, the handicrafts sector in India employs about 68, 86,000 artisans[21]. It is important to note, that the handicrafts and handloom sector is an important conduit of women empowerment. For example, according to the latest Handloom Census, approximately 72 per cent of the handloom workers are females[22]. Similarly, about 56 per cent of the artisans engaged with handicrafts are females[23]. However, the financial condition of the artisan community is a matter of grave concern. As per estimates, artisans and weavers are the third largest segment among the poor[24]. According to the latest estimates provided in the All-India Handloom Census 2019-20, for 66 per cent of weaver households average monthly income from all sources is less than Rs 5,000. Additionally, about 25.5 per cent of the weaver households are Antodaya card holders, reflecting the abject situation of the artisans associated with the sector[25]. Further, COVID-19 has aggravated artisan vulnerability[26].
6. Thus, there is need to put in place suitable mechanisms, especially those that leverage technology and innovation to positively disrupt the handicrafts and handloom industry, address the perennial problems pertaining to productivity, improve quality in tandem with latest trends in the international markets, and build robust technologically advanced post-production value chains to capture premium values, thereby translating into higher revenues, foreign exchange, and ultimately higher remunerative wages for the artisan community.

[20] ibid

[21] Ibid

[22] 4th All India Handloom Census Report (2019-20)

[23] IBEF (Last Accessed on July 24, 2023)

[24] Roy and Khan (Last Accessed on July 24, 2023)

[25] All-India Handloom Census 2019-20 (Accessed on August 4, 2023)

[26] ibid

Handicrafts and Handloom – Jammu and Kashmir

1. Dating back centuries, the handicraft and handloom industry of Jammu and Kashmir is an embodiment of the region's rich cultural heritage and a testimony to the exquisite crafts(wo)manship of the artisan citizenry. The sector witnessed significant growth during the 14th century owning to the contributions of the Persian Sufi Saint – Shahi Hamdan[27] who brought along with him skilled artisans and was instrumental in introducing varied innovative techniques and designs.

Fig 6: Artisans weaving Kani Shawls and Carpets

2. According to Jammu and Kashmir's latest Wool Processing, Handloom, Handicrafts Policy[28], the major handloom and handicrafts products from the region includes – weaving of specialized fabrics like Pashmina, Kani, and Raffle Shawls, blankets like Lois and Chashme Bulbul, cotton and Arabian Rumals, Tweed and linen fabrics, Sozni, Crewel, Papier Mache, Ari Staple, Khatamband, Chain stitch, Calico printing, Zari embroidery, Tilla embroidery, Paper pulp/Sakhta, Chamba embroidery, Willow wicker, Tapestry, Wheat straw, Phoolkari, Namdah, Carpet weaving, Gabba making, Chickri wood, Basholi painting, Wood carving, Bamboo work, Meenakari, Lathe-cum-lacquer, Toy and doll, and Copperware.

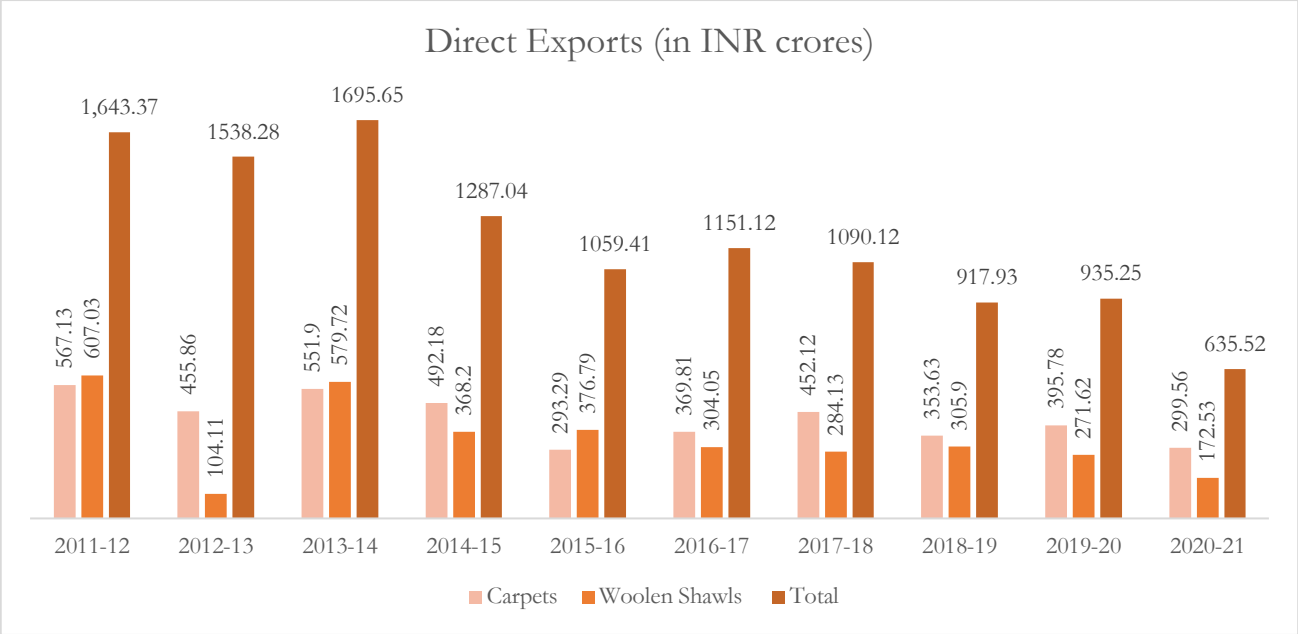
[27] Lone (2023, p23) [Accessed on July 31, 2023]

[28] Jammu and Kashmir Wool Processing, Handloom, Handicrafts Policy 2020 (Accessed on July 31, 2023)

3. The handicrafts and handloom sector are one of the main stays of the region's economy and holds immense socio-cultural importance. The twin sectors directly or indirectly employ almost 3.5 Lakh artisans, and thus present a significant employment generation potential and are critical from a human development perspective.
4. Additionally, despite their unorganized and cottage industry nature, the sectors contribute significantly to the GDP of the UT. However, between 2011-12 to 2020-21, the total handicrafts and handloom exports from the region have witnessed a decline from about INR 1,643 crores to INR 635 crores (ref Fig 7).
5. As highlighted previously, evidence gathered both during AGNIi field visits in Srinagar and via secondary research[29], suggests that the profitability from the sectors is declining and this can be primarily attributed to – a pervasive network of middlemen eroding profits for artisans; undifferentiated mixing of cheap machine-made products with original handmade products in the market depressing both prices and wages; lack of mechanisms to check counterfeiting; lack of narrative based branding and marketing that help end buyers realise the products actual worth; low productivity; and quality challenges for example, usage of chemical dyes that impede fetching higher prices in global markets rallying towards sustainability. Further, declining profitability has reduced inter-generational self-employment in these sectors resulting 'languishing crafts', which threatens the very existence of these centuries old crafts – an important symbol of India's cultural heritage.
6. Considering the livelihood and export potential of the handicrafts and handloom sector of Jammu and Kashmir it becomes imperative to arrest the various challenges impeding sectoral growth via regulation, policy, and technology.

[29] ibid

Fig 7: Handicraft and Handloom Export from Jammu and Kashmir



Note: Total also includes Namda, Crewel embroidery, Wood carving, Paper-Mache, Fur & Leather, Chain-stitch goods, and other handicraft goods. There were missing values for the majority of the years for these categories, hence have not been utilized for the creation of the graph.

Source: Digest of Statistics 2020-21[30], Jammu and Kashmir

[30] Digest of Statistics 2020-21

Interactive Experience Section: Kashmiri Craft Clusters

Glimpses from the handloom workshops around Srinagar, Kashmir

Strategic Factors Defining Technology Adoption: Scaled Impact against a Scaled Challenge

1. This TAN describes how technology and innovation – capabilities of which exist in India – can help strengthen and transform India's handloom and handicrafts sector and reduce the vulnerability of dependent artisan communities from the threat of machine-made products, improve artisan productivity, enhance product quality, and preserve the skills of master artisans to ensure inter-generational continuance of the crafts. Technology can be an effective enabler that can equip the artisans to compete better in global markets. Developed in collaboration with the Directorate of Handicrafts and Handloom, Kashmir, the TAN engages a scaled challenge.
2. Technology intervention answering its challenges – in use-case selection and solution deployment – are **similarly scaled in impact**.
3. The technology stack will help the sector gain competitive advantage in global markets, improve wages for the artisan community, and instrumentally prevent the crafts from languishing.

Table 3: Strategic Factors defining Technology Adoption

S. No.	Strategic Factor	Functional Implication	Technological Response: Consequences for Technology Stack Composition
1.	Counterfeiting of handmade products both handicraft and handloom: • Inability to authenticate genuine handmade Kashmiri products • Depresses product price, dwindling revenue, and artisan wages • Low wages disincentivize weavers to produce high quality work • Inability of consumers to appreciate as well as identify genuine handmade products, and hence pay commensurate prices	Visual display to establish product differentiation, provenance tracking, payment tracking, identification of handloom vs. power loom products, technologies to display the arts and crafts, and precise mapping of authenticity of Pashmina with BIS and global standards	Blockchain based provenance tracking: To map the product cycle effectively from procuring the wool to selling the finished product. IoT based Authenticity Checks: Using IoT devices to capture the motion of a handloom and the artisans to differentiate between handmade and machine-made products. Physically Unclonable Functions based QR Codes:

S. No.	Strategic Factor	Functional Implication	Technological Response: Consequences for Technology Stack Composition
			Ensuring that the QR codes deployed for creating a digital presence of a particular product is physically unclonable and cannot be counterfeited. <u>Immersive Experiences for Customers:</u> • Using holography and XR to create Digital museums for showcasing the various Handicrafts and Handloom products. • Using Virtual Reality and Web based Augmented Reality to create an immersive shopping experience for the customer. • Using narrative technologies to capture the manufacturing processes to ensure the customer understands the various intricacies associated with it.
2.	Diminishing inter-generational transfer of artistry skills resulting in 'languishing crafts': • Languishing Skill Base – undermines value creation & revenue generation	Augmenting the production process to create immersive experiences, digitizing the handicrafts and handloom production processes, creating digital knowledge and design banks, visually documenting the	<u>Mixed Reality:</u> Creating a digital repository for the various processes involved in the Handicrafts and Handloom clusters and using immersive experiences and narrative technologies for

S. No.	Strategic Factor	Functional Implication	Technological Response: Consequences for Technology Stack Composition
	• Inability to preserve the heritage knowledge and skills of the ageing master artisans	crafts and their intricacies, developing online training courses for artisans, creating a digital archive of traditional artistry skills, and supporting research and development in traditional artistry	knowledge transfer to newer generations of weavers and artisans.
3.	Machines and processes have not been upgraded or retrofitted in decades. Limiting the ability to compete in global markets: • Lack of machines Upgradation • Need for semi-mechanisation of machinery • High turnaround times	Need for assistive technologies for the artisans and retrofitting machinery while retaining the "hand" in both the craft and loom	<u>Assistive Technologies:</u> • Eye & nose protective gears • Magnification for intricate works • Retrofitting the existing machines for comfortable sitting • Semi-mechanisation of machinery to aid the artisans <u>Computer Vision for Digitisation:</u> Using Computer Vision based software for digitisation of Taleems and to generate designs from them. This can also be used to generate new Taleems for corresponding designs.

S. No.	Strategic Factor	Functional Implication	Technological Response: Consequences for Technology Stack Composition
4.	Ensuring product and process sustainability is a challenge: • Unavailability of organic and sustainable dyes for Pashmina and Wool carpets • Lack of effluent management	Need for low-cost sustainable/natural dyes, the use of local raw materials for manufacturing of dyes, and the development of an effluent management system	<u>Natural Dyes:</u> Using naturally sourced dyes to prevent polluting the environment. <u>Effluent Management System:</u> Deploying an effluent treatment system to ensure any effluents generated during the manufacturing processes are treated before their disposal.

Strategic Context

Pain Points and Operational Scenarios: Surfaced through Fieldwork

Pain points afflicting the Kashmiri Pashmina and carpet industry were surfaced by AGNIi Mission during the field visit to Srinagar during December 2022. The Mission team interacted both with artisans and officials from the Directorate of Handicrafts and Handloom, Kashmir, and its allied agencies. These include interactions with – School of Design, Craft Development Institute, Pashmina Testing Facility, and artisans in the craft clusters of Narwara, Kathidarwaza, Zadibal, Bagh Ali Mardan Khanin Srinagar. The below table (Table 4) maps the pain points and operational scenarios, which surfaced during the field visit with the technology use cases along with associated desired functional requirements from technology.

Fig 8: Field Visits to craft clusters in Srinagar

Table 4: Pain point mapping for Kashmiri Pashmina and Carpets

#	Pain Point	Operational Scenarios	Use Case	Functional Requirements
1.	Inability to authenticate genuine Kashmiri handicrafts and handloom products Inability to articulate the narrative behind Kashmiri Handicrafts & Handlooms	• Markets are dumped with cheap machine-made products from Amritsar and Ludhiana which are passed off as handmade products. This depresses wage for Kashmiri artisans (as low as Rs 200/ day, where day is about eight hrs). • Kashmir Pashmina is 11-15 microns whereas American Cashmere is 11-18 microns. This difference is not known to everyone. • High end products only suitable for niche export markets or high net worth individuals • Marketing & branding is primarily done by exporters. • Middlemen erode artisan's revenue share. • The Department has developed tags for both GI and non-GI products, which are embossed in the products – multiplicity of labels – plastic, hologram, and fabric based. • QR codes have been developed for authentication. These will make consumers aware about product specifications including artisan details.	Verification of authenticity of Kashmiri handicrafts and handloom products	Product authentication by implementing techniques like unique identifiers, holograms, or digital certificates to authenticate genuine products and protect against counterfeiting. Premiumization focuses on enhancing the value proposition of products by emphasizing their superior quality, crafts(wo)manship, ethical sourcing, sustainability, or luxury branding, resulting in a higher perceived value among consumers. Creation of digital environments that fully engage and captivate users, simulating real-world or fantastical scenarios through technologies such as virtual reality (VR), augmented reality (AR), or mixed reality (MR). These experiences leverage a combination of visual, auditory, and even tactile elements to create a sense of presence and deep engagement, blurring the boundaries between the physical and digital worlds. Users can interact with and explore these immersive environments, often in real-time,

#	Pain Point	Operational Scenarios	Use Case	Functional Requirements
		• However, there is scope to bring the information reflected post scanning of QR codes to global standards as highlighted by research and development institutes.		allowing for dynamic and interactive storytelling, training simulations, etc 1. XR to capture and preserve traditional skills through immersive experiences, to facilitate skill enhancement, knowledge transfer, and the continuity of cultural heritage 2. Immersive experiences that showcase the crafts(wo)manship, quality, and cultural significance of handmade items. Through virtual showrooms and interactive experiences, XR elevates the perceived value, exclusivity, and desirability of the products. 3. Physically Unclonable Functions for each product, to establish authenticity and eliminate counterfeits. 4. Sensors to authenticate the motion of a handloom and further help differentiate between a handmade and a machine-made product. 5. Optical Sensor based system to detect knots per inch in a carpet/shawl

#	Pain Point	Operational Scenarios	Use Case	Functional Requirements
5.	Languishing heritage, knowledge, and skills of ageing Master artisans	• Most master artisans (at present 250 master artisans) are very old or ageing, and there is need to preserve their knowledge and expertise of Kashmiri handicrafts and handlooms to prevent them from falling in the category of languishing crafts. • No platform for artisans to become aware of global best practices and designs. At present, the School of Design and Craft Development Institute works on innovative product prototypes that might have a higher market uptake. These designs can be procured from these institutes for free by the artisans. • No knowledge exchange programme between School of Design and Craft Development Institute. • The Museum operated by the School of Design was destroyed in the floods of 2014 and requires upgradation. • No digital infotainment interventions present in the School of Design Museum.	Preservation of the skills of Master Artisans Dissemination of knowledge to budding artisans Interactive museum infotainment	Systematic recording and documentation of the steps, procedures, and specifications involved in the production of goods or products using: Cameras: - High-resolution cameras (e.g., 4K or higher) capable of capturing detailed visuals. - Adjustable focus, aperture, and exposure settings for capturing different lighting conditions. - Wide-angle lenses for capturing a broader field of view or macro lenses for capturing intricate details. - Stabilization features (e.g., optical or electronic image stabilization) to minimize camera shake. - Support for manual control over settings, including white balance and shutter speed. Audio Equipment: - High-quality microphones for capturing clear audio, such as lavalier or shotgun microphones. - Noise-cancellation or windscreen accessories to reduce unwanted background noise or wind interference. - Adjustable gain settings for controlling audio levels and

#	Pain Point	Operational Scenarios	Use Case	Functional Requirements
				minimizing distortion. - Compatibility with the recording device or camera used for synchronized audio capture. Other Sensors: - Light meters or colorimeters to ensure accurate color representation. - Environmental sensors (e.g., temperature, humidity) for monitoring and maintaining optimal conditions during manufacturing processes. - Motion sensors or accelerometers to capture movement or vibrations during specific manufacturing steps. - Proximity sensors or distance measuring tools for ensuring precise measurements or positioning. - LIDAR Sensors to capture 3D images of finished products. A cloud-based web platform with: Cloud based server to host data: - Reliable and scalable cloud hosting services (e.g., Amazon Web Services, Microsoft Azure, Google Cloud) to ensure high availability and performance. - Adequate storage capacity to accommodate the volume of digitized data and allow for future

#	Pain Point	Operational Scenarios	Use Case	Functional Requirements
				scalability. - Robust security measures to protect data confidentiality and integrity, including encryption and access controls.
6.	Non-modernisation of legacy tools and equipment with productivity and health implications	• Handmade products have a significantly higher production time compared to machine counterparts. For example, there is a huge market for Christmas balls, however, producers are unable to fulfill orders. • Intricate work like Kani is done without any aid. This leads to multiple health hazards like eye straining (improper lightening in the work area; frequent power cuts), fiber inhalation. • Tools & technologies have not been upgraded in the past four decades at least. • About 10 grams of yarn is made in 3-4 days with 3-4 hours of per day work. • Traditional loom designs are 200-300 years old. • Traditional Charkhas operated by hand have at some places been replaced by Modern Charkhas operated by the feet. • Machines made of iron render useless in the winters due to the extreme cold.	Artisan centric modernisation of the existing machinery (tools and looms)	Semi-mechanisation of equipment by introducing mechanical components or automated features to traditional manual processes, optimizing productivity and quality while preserving artisanal crafts(wo)manship: 1. Micro Level wool processing units for deployment a cluster scale 2. Mechanised rollers for Namda manufacturing which make the process less labour intensive 3. Motorised versions of charkhas for spinning of fiber

#	Pain Point	Operational Scenarios	Use Case	Functional Requirements
		• Master artisans are rare & the majority of them are senior citizens. • Taleem's font is significantly smaller and hence difficult to read. • No visualization of the end-product for the artisan to realize mistakes – in some instances utilization of graph paper with the design printed on it (but only observed in School of Design) • At present no carding machines that are ideal for carding Pashmina – at present cotton carding machines have been retrofitted – this breaks the length of the fiber. • Imported carding machines are very costly.		
7.	Lack of a vibrant natural dyes' palette for pashmina and carpets	• Artisans are working in different Karkhanas. Hence, the value chain is very spread out and primarily home based. • Global counterparts of Pashmina such as Cashmere are engaging with sustainable and organic dyes, which fetches a higher market value. • At present, quality checks & assurances are done manually. • Inability to engage with the organic dyeing clusters of Jaipur.	Development of vegetable based and sustainable material dyes preferably from local flora. Tools for identification and mapping the shades for standardisation of dyes	Adopting environmentally conscious methods and strategies to minimize negative impacts on the environment, promote social responsibility, and ensure long-term viability: 1. Naturally sourced dyes 2. Deploying an effluent management system

#	Pain Point	Operational Scenarios	Use Case	Functional Requirements
		• Centralised Dyeing facility being setup – there will be user charges. • Present cost economics of dyes – organic dyeing cost Rs 250/gram whereas for chemical dyeing cost is Rs 100/gram		

User Persona Mapping

1. User persona mapping refers to the process of collating and segmenting information about potential decision makers[31] and technology adopters. The key objective of the process is to create archetypes of potential technology adopters and decision makers pertaining to procurement and financing. The creation of decision maker and technology adopter archetypes helps in ensuring that the process of technology scouting is precise. This feeds into the larger goal of ensuring technology adoption by bringing the technology that solves the user problem most effectively. This section (refer table 5) presents details of user persona mapping at the three different tiers - strategic, operational, and field, which involves decision makers and potential adopters for each layer in the technology stack.

Fig 9: Stakeholder Interaction with Director Handicrafts & Handloom, Kashmir

[31] Please note that in certain scenarios the decision makers and adopters of technology can be different

Table 5: User Persona Mapping

Decision-Making Tier	• Strategic • UT Administration: Represented by Ministries of Commerce and Industry, Government of Jammu and Kashmir	• Operational • Directorate of Handicrafts and Handloom | Allied agencies: Indian Institute of Carpet Technology | Craft Development Institute | School of Design | Wool Processing Unit	• Field • Artisans • Manufacturers and Exporters
Role and Key Priorities	• Role: • Facilitate deployment of innovations and technologies. • Designing procurement and technology funding mechanisms. • Key Priorities: Increasing employment generation, improving artisan incomes, increasing exports and export revenue, improving human development outcomes, helping Kashmiri handicrafts and handloom products gain competitive advantage globally, preserve the UT's cultural heritage	• Role: • Incorporating mechanisms to preserve the sector from the perils of machine-made products via appropriate policies and plans. • Operationalising procurement; sanctioning funds; capacity building of manufacturers/exporters and artisans. • Key Priorities: Increasing employment generation, improving artisan incomes, increasing exports and export revenue, improving human development outcomes, helping Kashmiri handicrafts and handloom products gain competitive advantage globally, preserve the UT's cultural heritage	• Role: • Facilitating technology adoption. • Funding and procurement; Awareness about new technologies; change agents; capacity building of artisans. • Key Priorities: Improvement of artisan incomes; productivity enhancement; ergonomic interventions

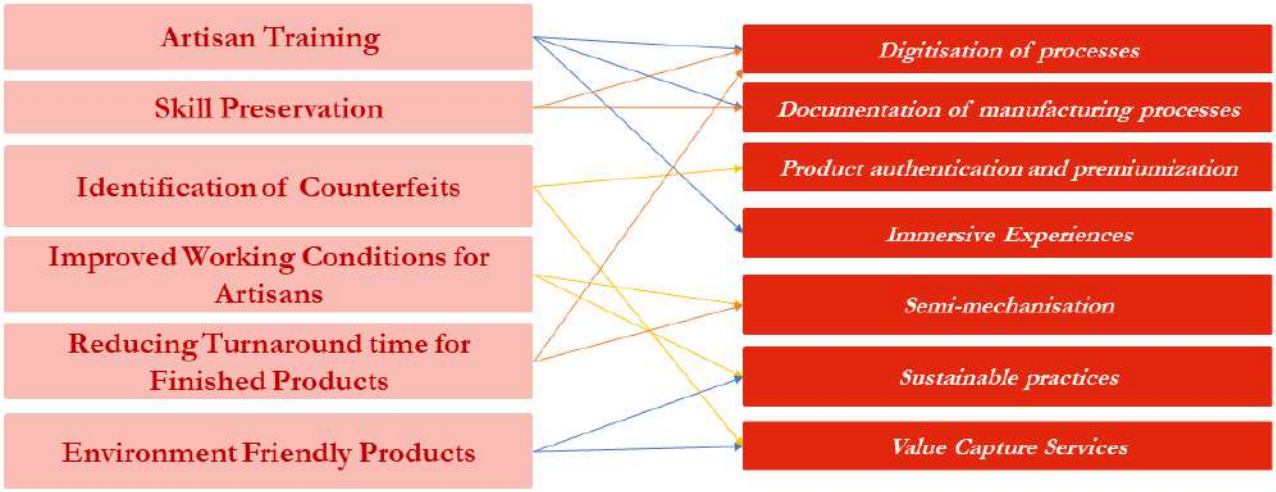
Decision-Making Tier	• Strategic • UT Administration: Represented by Ministries of Commerce and Industry, Government of Jammu and Kashmir	• Operational • Directorate of Handicrafts and Handloom| Allied agencies: Indian Institute of Carpet Technology| Craft Development Institute| School of Design| Wool Processing Unit	• Field • Artisans • Manufacturers and Exporters
Attitudes and Interests	• UT administration is keen on adopting both frugal and emerging technologies • With regards the production process, focus is on semi-mechanization. Meanwhile, for post-production segments of the value chain there is intent to leverage emerging technologies • Frugal technologies like Namda roller as well as emerging technologies like mixed reality enabled metaverse were equally appreciated by the administration	• The Directorate has proved to be an innovator by virtue of being one of the first departments in the country to implement QR code technology for handloom and handicrafts • The Directorate through its allied institutions is working on various R&D projects such as sustainable dyes from local flora, ergonomic looms, digitization of taleems • The objective of the Directorate is to increase productivity and enhance quality via semi-mechanization and they are interested to facilitate co-development of solutions for the same • The Directorate is keen to leverage emerging technologies for post-production segments as well as for preservation of languishing skills & craft processes	• Representatives from manufacturers and exporters were interested in frugal technologies for semi-mechanization of production process to reduce production time, make tools and equipment's ergonomic for the artisans. Additionally, they were interested in emerging technologies for marketing and branding • The manufacturers and exporters are working towards semi-mechanization: One of the exporters has taken pro-active measures for mechanization of the traditional Charkha • There is need for massive awareness

Decision-Making Tier	• Strategic • UT Administration: Represented by Ministries of Commerce and Industry, Government of Jammu and Kashmir	• Operational • Directorate of Handicrafts and Handloom| Allied agencies: Indian Institute of Carpet Technology| Craft Development Institute| School of Design| Wool Processing Unit	• Field • Artisans • Manufacturers and Exporters
			campaigns for sensitizing artisan communities as they are the ultimate end users
Behaviour and Decision Triggers	• Emphasis is on technologies which can enable the hand vs technologies that could replace the hand		
	• The focus is to establish a balance between emerging technologies & frugal innovations which would facilitate faster adoption • The administration focuses on solutions which are scalable across the UT	• The Directorate is willing to immediately to explore adoption of ready to deploy technological solutions • The Directorate is exploring co-development of technologies with R&D labs in a phased manner	• The artisans prefer cost-effectives solutions whereas the manufacturers and exporters are open to explore premium technologies as well

Need -Feature Mapping

1. The pain-points and operational scenarios for Innovations in Handicrafts and Handlooms were surfaced via field work, which comprised focused group discussions and key informant interviews with relevant stakeholders (representatives of the Directorate of Handicrafts and Handlooms, local artisans, and rural communities).
2. Subsequently, the pain-points and operational scenarios were translated into technological functional requirements, which were utilized for scouting relevant innovators. This section maps the pain-points and needs of end adopters with relevant technology use cases.

Fig 10: Need Feature Mapping



Technology Stack

1. Based on the above-mentioned need-feature mapping, technological capabilities that have the capacity to address the needs, and their relevance to the end-user are mapped in the following figure (refer Fig 10) and matrix (refer table 6). The various layers of the matrix are:
    a. Feature and its description
    b. Technological capabilities and the specific layers that have the said features.
    c. Relevance in terms of the end adopter to tie the need with the end user

Table 6(a): Technology Stacks for Innovations in Handicrafts and Handloom - Preservation and Propagation of Handicrafts and Heritage

	Capture / Record	Demonstrate	Propagate
Mixed Reality	–	Converting the records into experiential learning through AR/VR and having simulation for product development processes for new artisans	XR to facilitate skill enhancement, knowledge transfer, and the continuity of cultural heritage
AI & Blockchain	OCR model to digitise Taleems and a deep learning algorithm to convert carpet designs into Taleems. Blockchain to create a chronological record of various activities involved.	Smart visualisation of existing 'Taleem' and generate new Taleems based on user input	–
IoT/CPS	Cameras, audio equipment and other sensors like motion sensors, etc to record and document processes	Optical scanner to read QR codes and other PUFs convert the output into user accessible data	
Digital Platform	Cloud based platform to store data and control access	Online repository to provide easy access to the digitised records to the artisans	Virtual showrooms and online platforms to offer a convenient and immersive way for artisans worldwide to explore and learn various handicrafts

Table 6(b): Technology Stacks for Innovations in Handicrafts and Handloom - (Re)- Premiuimisation for Handicrafts and Handloom Industry

	Trace	Differentiate	Authenticate	Building Narrative
Mixed Reality	–	–	–	Immersive experiences that showcase the craftsmanship, quality, and cultural significance of handmade items to elevate the perceived value, exclusivity, and desirability of the products
AI & Blockchain	Handicraft and Handloom products' integrated value chain with blockchain technology to create a seamless, transparent, and trustworthy end-to-end tracking of supply chain	Identifying the origin and characteristics of raw materials used to ensure consistency and quality in finished products	Providing a tamper-proof and transparent record of a product's journey from raw materials to finished goods	Enhancing brand value and differentiation by providing customers with detailed information about the products they purchase
IoT/CPS	Physically Unclonable QR Codes for each product, to establish authenticity and eliminate counterfeits	IoT devices deployed on handlooms to capture the motion and further differentiate between a handmade and a machine made product.	Optical scanner to detect knots per inch in a carpet/shawl Optical scanner to read QR codes and other PUFs convert the output into user accessible data	
Digital Platform	Connect artisans, weavers, traders, input dealers, logistics providers, academia, institutional buyers, POs, government departments and consumers. Interactions such as Information, help, advice, buy, sale and service happen between them solving each other's problems and benefitting together			

Table 7: Technology Prioritization Matrix for Innovations in Handicrafts and Handloom

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
Digitisation of processes	Transforming manual or analog procedures into digital formats, leveraging technology to streamline operations, improve efficiency, and enhance accessibility and accuracy of information	–	1. An OCR model to digitise Taleems. Data collection, annotation, image pre-processing, and utilizing Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), specifically the Long Short-Term Memory (LSTM) architecture, for digitizing Taleem image content. 2. A deep learning algorithm to convert carpet images into design representations, leveraging generative AI and super resolution technology.	A camera for OCR data capture with: 1. High Resolution: Full HD or 4K to enhance OCR accuracy 2. Quality Image Sensor: Larger sensor sizes 3. Autofocus and Macro: Autofocus for sharp text capture 4. Adjustable Exposure and White Balance 5. OCR Compatibility: Camera output to seamlessly integrate with OCR system, supporting standard image file formats.	–	–	1. The OCR model was able to identify and process initial data sets fed into it. The software will need more data sets and customisation to be able to process designs into taleems.	Pertaining to the availability of data sets for training, such technologies can drastically reduce the turnaround time for creating Taleems, which are the very foundation of carpet weaving. Additionally, will also enrich the design repository.

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
Documentation of Manufacturing Processes	Systematic recording and documentation of the steps, procedures, and specifications involved in the production of goods or products.	–	–	Cameras: - High-resolution cameras - Adjustable focus, aperture, and exposure settings - Wide-angle lenses - Stabilization features Audio Equipment: - High-quality microphones for capturing clear audio, such as lavalier or shotgun microphones - Noise-cancellation or windscreen accessories - Adjustable gain settings for controlling audio levels and minimizing distortion	A cloud-based web platform with: - Reliable and scalable cloud hosting services to ensure high availability and performance. - Adequate storage capacity to accommodate the volume of digitized data and allow for future scalability. - Robust	–	1. Various cameras and other sensors were able to capture and record the manufacturing process and map the intricacies involved in each step. 2. LIDAR scanners were able to create 3D images of finished products.	Documentation would help the Directorate in preserving the skills of Master Artisans. This will ensure their inter-generational propagation as well as to train youth that intends to foray into the art do not belong to artisan families.

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
				Other Sensors: - Light meters or colorimeters to ensure accurate color representation. - Proximity sensors or distance measuring tools for ensuring precise measurements or positioning. - LIDAR Sensors to capture 3D images of finished products	security measures to protect data confidentiality and integrity, including encryption and access controls.			
Product Authentication and Premiumisation	Product authentication involves implementing techniques like unique identifiers, holograms, or digital certificates	1. XR to capture and preserve traditional skills through immersive experiences, to facilitate skill enhancement, knowledge transfer, and the continuity of	_	1. Physically Unclonable QR Codes for each product, to establish authenticity and eliminate counterfeits. 2. IoT devices deployed on handlooms to	Virtual showrooms and online platforms offer a convenient and immersive way for customers worldwide to explore and	_	1. IoT Devices were able to capture the motion of the traditional handloom as well as the upgraded handloom. 2. Optical scanner	These technologies are key to helping genuine Kashmiri craft fetch its actual value and increase remuneration for the artisans.

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
	to authenticate genuine products. Premiumization focuses on enhancing the value proposition of products by emphasizing their superior quality, crafts(wo)manship, ethical sourcing, sustainability, or luxury branding.	cultural heritage 2. Immersive experiences that showcase the crafts(wo)manship, quality, and cultural significance of handmade items to elevate the perceived value, exclusivity, and desirability of the products		capture the motion and further differentiate between a handmade and a machine-made product. 3. Optical scanner with Machine Vision capabilities to detect knots per inch in a carpet/shawl	purchase these products, promoting cultural exchange, market expansion, and economic opportunities for artisans		was able to capture the per inch knottage. 3. The above information was readily integrated with a web-based platform to make it user accessible.	

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
Immersive Experiences	Creation of digital environments that fully engage and captivate users, simulating real-world or fantastical scenarios through technologies such as virtual reality (VR), augmented reality (AR), or mixed reality (MR). Users can interact with and explore these immersive environments, often in real-	1. XR to capture and preserve traditional skills through immersive experiences, to facilitate skill enhancement, knowledge transfer, and the continuity of cultural heritage 2. Immersive experiences that showcase the crafts(wo)manship, quality, and cultural significance of handmade items to elevate the perceived value, exclusivity, and desirability of the products	–	–	Virtual showrooms and online platforms offer a convenient and immersive way for customers worldwide to explore and purchase these products, promoting cultural exchange, market expansion, and economic opportunities for artisans	–	Immersive experiences were created for: 1. Manufacturing processes 2. Digital Museum for display of finished products 3. Narrative technologies to capture the artisans' stories 4. Metaverse and online shopping experience for end customers The users were able to have a holistic immersive experience and understand the	Deployment of these technologies is instrumental to make the end customer aware of the hours of eye hurting and back breaking work put by the artisans to produce exquisite Kashmiri handicrafts and handloom. Awareness of the 'story' is key for product premiumisation. Customers irrespective of geography can get

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
	time, allowing for dynamic and interactive storytelling, etc.						various steps involved in the manufacturing of products with the feature of buying the products from within the immersion	a 'feel' of shopping in Kashmir via creation of experiential marketplaces. Additionally, these immersive experiences can play an important role in creating infotainment spaces like museums, which help preserve and display the heritage.

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
Semi-mechanisation	Semi-mechanisation of equipment involves introducing mechanical components or automated features to traditional manual processes, optimizing productivity and quality while preserving artisanal craftspersonship	–	–	–	–	1. Micro Level wool processing units for deployment a cluster scale 2. Mechanised rollers for Namda manufacturing which make the process less labour intensive 3. Motorised versions of charkhas for spinning of fiber	1. The proposed mechanised equipment will enhance productivity and decrease the manual labour load on artisans and weavers.	Reducing artisan drudgery is one of the key objectives of the Directorate. Reduced drudgery makes the processes more artisan friendly and also increase productivity. Drudgery associated with crafts is a major reason for artisans to shift towards other vocations and abandon the craft leading them to

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
								become languished. Semi-mechanisation of certain processes can help do away with them same and bring more dignity to the processes.
Sustainable Practices	Adopting environmentally conscious methods and strategies to minimize negative impacts on the environment, promote social responsibility,	–	–	–	–	1. Using naturally sourced dyes 2. Deploying an effluent management system	1. Natural dyes were used to dye pashmina wool and were observed to retain the colour even after multiples washes. 2. Further collaboration is needed to source	Adoption of natural dyes made from local flora make the products more sustainable increasing their value in global markets.

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
	and ensure long-term viability.						the dyes from local flora in Kashmir.	
Value Capture Services	Connect artisans, weavers, traders, input dealers, logistics providers, academia, institutional buyers, POs, government departments and consumers. Interactions such	Redirecting users to immersive experiences using QR codes or other digital accessibility parameters	Handicraft and Handloom products' integrated value chain with blockchain technology to create a seamless, transparent and trustworthy end-to-end tracking of supply chain	Optical scanner to read QR codes and other PUFs convert the output into user accessible data	Digital platforms to use technology to manage the whole supply chain, from design inputs to last-mile distribution.	–	1. The technology providers apprised the directorate officials of the benefits of developing digital platforms to build market access and linkages.	Such technologies will help do away with geographical barriers related to physical markets. The Directorate is interested in digitizing the value chain. They want to explore digital

Feature	Description	Capability					Performance	Relevance
		XR	AI & Blockchain	IoT/CPS	Digital Platform	Mechanised Equipment & Chemicals		
	as Information, help, advice, buy, sale and service happen between them solving each other's problems and benefitting together							marketplaces for premiumization. Developing an end-to-end value chain (especially marketing and branding of products produced in the region) is of utmost importance for value capture.

Field Technology Showcase and Demonstration

1. To demonstrate the technology stack's practical potential (pathway 1)– actual impact on the ground, for Government decision-makers, against these priorities – the AGNIi team conducted a Field Technology Showcase (FTS) at Srinagar, Jammu and Kashmir.
2. Prior to the FTS, a virtual showcase of various technologies was conducted in the presence of officials from the Directorate of Handicrafts and Handloom, Kashmir. The primary objective of the virtual demonstration was to gauge the level of response from the key stakeholders. The technologies showcased included mixed reality for (re)-premiumization, Physically Unclonable Functions and blockchain for robust provenance tracking, machine vision for authentication of products.
3. The technologies shortlisted from the virtual technology showcase were then demonstrated on field, in Srinagar, in the presence of the Commissioner-Secretary of Department of Industries and Commerce, J&K and the Director of Handicrafts and Handlooms, Kashmir.
4. A total of five Indian innovators participated to conduct a field showcase of technologies in the domains of virtual and augmented reality for creation of a metaverse, immersive shopping experience and narrative technologies to capture the essence of the manufacturing processes involved in various handicrafts and handloom products; IoT devices to differentiate between handmade and machine made products; machine vision based optical analyzer to detect the knots per square inch in a carpet; and a machine vision based Optical Character Recognition (OCR) model for digitization of Taleems.
5. To enable adoption of these technologies by the decision makers, FTS focused on demonstrating Everett Roger's adoption levers for each technology.

Fig 11: Field Technology Showcase, Srinagar – Narrative Technology using XR and IoT Device for Handloom Authentication

Adoption Levers

1. Everett Rogers in his seminal work Diffusion of Innovations[32] stated that the perceived attributes of innovation (characteristics of innovations, as perceived by individuals) play a key role in determining the rate of adoption of innovation. According to Rogers, there are five important attributes of innovation, these include:
    a. Relative Advantage: Refers to the degree to which an innovation is perceived as better than the idea it supersedes. The numerous factors by way of which the degree of relative advantage can be measured include – economic terms, social prestige factors, convenience, and satisfaction.
    b. Compatibility: Refers to the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
    c. Complexity: Refers to the degree to which an innovation is perceived as difficult to understand and use. Some innovations are easy to understand and hence, easily adopted. Meanwhile, others may not be very straightforward, which slows the adoption process.
    d. Trialability: Refers to the degree to which an innovation may be experimented with on a limited basis.
    e. Observability: Refers to the degree to which the results of an innovation are visible to others. The ease with which individuals can see the results of an innovation has a direct impact on the probable likelihood of their adoption.
2. The perceived attributes of innovation are instrumentally important. This is because end adopters are primarily artisan communities and there exist information asymmetries with respect to both functionalities and the benefits of technology innovation. In this context, one of the key objectives of the Field Technology Showcase was to exhibit and contextualise the above attributes of innovation.
3. The subsequent table in the section enumerate the five important attributes of innovation and how each was conveyed to the decision makers and technology adopters by way the field showcase with reference to the different layers and technologies of the technology stack.

[32] Rogers, E. M. (1962). Diffusion of innovations. New York, Free Press of Glencoe.

Table 8: Adoption Levers

#	Adoption Lever	Mixed Reality	IoT Authentication Devices	Machine Vision for Digitisation	Physically Unclonable Functions (PUF)	Market Access and Linkages	Natural Dyes
1	**Relative Advantage**	• These technologies aid in creating an immersive experience for the consumers leading to differentiation of handmade and machine-made products. Thus, enabling better prices for the genuine products • These technologies eliminate geographical barriers and dependency on	• IoT Authentication Devices enable capturing and quantification of the handicraft and handloom processes which aid in differentiation of handmade and machine-made products	• Machine-vision based digitization of Taleems can be done in a much shorter turnaround time as compared to the traditional method of typing in each character into the conversion software.	• 3D QR Codes with a PUF cannot be counterfeited. • Each product will have a PUF backed authenticity check and will eliminate the need of user awareness as is in the case of Directorate's QR Codes which have nano-particles embedded in them.	• Technology providers appraised the Directorate about the benefits of developing digital platforms to build market access and linkages via success stories created in other Indian states. • The resultant gains from removing intermediaries from the value	• There is a rallying cry for sustainability in global handicrafts and handloom markets. As such utilisation of natural dyes can help fetch higher prices. • Environment friendly, reduced effluent treatment costs.

#	Adoption Lever	Mixed Reality	IoT Authentication Devices	Machine Vision for Digitisation	Physically Unclonable Functions (PUF)	Market Access and Linkages	Natural Dyes
		physical infrastructure				chain were conveyed.	
2	**Complexity**	• The Directorate as well as exporters recognized the utility of mixed reality technologies. However, the implementation will have to be in a phased manner starting from simple technologies with	• The Directorate and the manufacturers found the IoT Authentication devices easy to deploy	• Once deployed, the user needs to scan the Taleem using any smartphone or a digital camera. • The design team at IICT recognized the ease of use of the technology. • The technology would require a large number of data sets, i.e., Taleems and	• The technology is easy to understand and deploy for a large range of products.	• Directorate recognized the need for digitizing & organizing the handicrafts and handloom sector, however solutions proposed require mass awareness campaigns and involvement of manufacturers and exporters to help in	• Identification of local flora to develop natural dyes would require extensive studies. • Development of a varied and vibrant colour palette could be a constraint.

#	Adoption Lever	Mixed Reality	IoT Authentication Devices	Machine Vision for Digitisation	Physically Unclonable Functions (PUF)	Market Access and Linkages	Natural Dyes
		lower investments. • Technologies are available in a varied spectrum with the simple being adoptable by the small artisan workshops whereas the resource intensive being adoptable by the government and large exporters		their digitized versions for the software to be accurate. • Technology might not be accurate if the characters to be recognized are not crisp and clear, since Taleems are handwritten.		development of forward linkages and to support technology adoption.	
3	**Compatibility**	• Mixed reality technologies can be integrated into	• The data captured by the IoT Authentication	• The technology will be compatible with	• The technology is a substitute to the QR code	• The Directorate is working towards building	• The Directorate is keen on developing natural

#	Adoption Lever	Mixed Reality	IoT Authentication Devices	Machine Vision for Digitisation	Physically Unclonable Functions (PUF)	Market Access and Linkages	Natural Dyes
		the current website of the Directorate/ exporters • The Directorate can integrate these technologies with their QR code system	devices can be integrated in the current QR based authentication system • The devices can be easily mounted on the looms and are comfortable to wear by the artisans	the already existing digitization software, 'Naqash'	technology already put in place by the Directorate and its adoption will require them to replace the existing QR Codes and setup a new system.	digital market platforms and on-board artisans registered with them. Similarly, the manufacturers and exporters are establishing digital market platforms	dyes and raise awareness regarding the same among artisans. • IICT is already working towards development of natural dyes from local flora.
4	**Trialability**	• The Directorate is keen on implementing mixed reality technologies in government owned institutions	• The Directorate is willing to explore the deployment of the devices on the looms to strengthen the authentication process	• The technology can be trained with the already digitized Taleems and then tested for accuracy.	• The technology can be deployed for a particular range of products to establish and verify the level of provenance tracking.	• The Directorate is keen on leveraging online marketplaces for premiumization of high-value products as a first	• IICT is willing to try the natural dyes as they are involved in the research and development of the same.

#	Adoption Lever	Mixed Reality	IoT Authentication Devices	Machine Vision for Digitisation	Physically Unclonable Functions (PUF)	Market Access and Linkages	Natural Dyes
		like museum and emporiums				step towards digitization.	
5	**Observability**	• The Directorate, manufacturers and exporters experienced the mixed reality solutions like VR and AR which enabled them to have understand efficiency of mixed-reality technologies for creating	• The productivity parameters were showcased to the Directorate using the data captured by the IoT devices	• The designers at IICT were able to observe the relative speed with which the technology can digitize a Taleem. • The accuracy of the digitization needs to be amped up with more data sets.	• The effectiveness of PUF as a means to authenticate products and establish an anti-counterfeiting mechanism was observed.	• The process of digitizing & organizing the handicraft and handloom economy is a slow process and requires consistent efforts. • The Directorate could witness the impact of the marketplaces on	• The natural dyed fabric samples showcased by BTRA to the Directorate were praised for their colour quality and brightness

#	Adoption Lever	Mixed Reality	IoT Authentication Devices	Machine Vision for Digitisation	Physically Unclonable Functions (PUF)	Market Access and Linkages	Natural Dyes
		immersive experience for the consumers				premiumization of the high-value products.	

Field Immersion Workshop

1. Simultaneous with the FTS, the AGNIi Mission also organised a Field Immersion Workshop at Srinagar, Jammu and Kashmir. The intent of the Immersion Workshop was to familiarize the research and development institutes – Bombay Textile Research Institute (BTRA) and Wool Research Association (WRA), and RuTAG centers of IIT Roorkee and IIT Madras as well as the start-ups, with the Pashmina and Carpet weaving supply chain in particular and also give a brief idea of the other crafts of Kashmir.
2. The objective was to enable identification of additional pain points pertaining to enhancement of productivity and improvement of quality, for which there exists a possibility of augmenting/retrofitting/improving existing technology solutions under AGNIi Pathway 2
3. For the Field Immersion Workshop, the participants interacted with the artisan community and officials of the allied agencies of the Directorate. During the Immersion Workshop the participants visited – the School of Design, Craft Museum, Indian Institute of Carpet Technology, Craft Development Institute, Wool Processing Unit, Dyeing clusters, Pashmina testing facility, Pashmina weaving centres, and manufacturing and export units, carpet weaving clusters, and interaction with Namdah and Pataj makers.
4. As a result of the Field Immersion Workshop, the following technologies/areas for technology augmenting/retrofitting/ and improvement have been identified by BTRA, WRA, RuTAG IIT Roorkee, RuTAG IIT Madras, and startups (please refer annexure for detailed Concept Notes of research and development institutes and RuTAGs).
    a. Natural dyes using local flora and fauna; lustrous natural dyes for silk carpets.
    b. Development of cheaper and ergonomically better fleece removal tool
    c. Mechanized rollers for Kashmiri Namdah
    d. Micro-wool processing units that can be deployed in clusters.
    e. Standardisation of carpet washing process
    f. Machinery Upgradation at Wool Processing Unit
    g. Effluent treatment
    h. Development of splitting machine for willow wicker
    i. Exploratory R&D for developing suitable technology for weaving Waguv Mats (Grass mats)
    j. Motorisation of Charkha that allows for speed control and hence suitable for delicate Pashmina yarn
    k. Digitising carpet designs and converting them into Taleems

Fig 12: Field Immersion Workshop (Craft Development Institute and Dyeing Cluster)

Fig 13: Field Immersion Workshop (Carpet Manufacturer & Exporter)

Way Forward and Conclusion

1. The FTS conducted at Srinagar, Jammu and Kashmir has provided a platform for the development and sharing of innovations for Handicrafts and Handloom. These technologies have the potential to (re)premiumise various products within the sector while preserving the traditional skills ensuring the same are propagated to younger generations of artisans. The technologies can also aid and enhance their productivity and quality of products.
2. The state administration can explore varied mechanisms to procure the ready-to-deploy technologies. Those in the domain of mixed reality and authentication can be adopted on an immediate basis. Similarly, the administration can initiate the process for technology transfer of commercialized ready-to-deploy tools like Namdah rollers developed by research and development institutes and RuTAGs.
3. Ready to deploy technologies in the handicrafts and handloom ecosystem are limited given the lack of awareness, availability of market and highly contextual use cases. The Directorate and its allied agencies are already pioneers in implementing innovative technologies. Hence, they can initiate and spearhead the co-development of customized technology solutions in association with research and development institutes and RuTAGs.
4. The administration can explore development of Common Facility Centers and/or leverage the clusters and artisan networks for deployment of cost intensive but impactful technologies, which artisans and small manufacturers cannot individually deploy.
5. The final deployment of the demonstrated technologies is ongoing, and the document will be updated once it has been shared with the AGNII Mission. Till then, the indicative way forward is indicated in the table (refer Table 9).

Table 9: Assessment and Advisory Matrix

Strategic Context Factor	Functional Requirement	Idealised Capability Requirement	Capabilities Indicated in Field Technology Showcase	Course of Action
Counterfeiting of handmade products both handicraft and handloom: •Inability to authenticate genuine handmade Kashmir products • Depresses product price, dwindling revenue, and artisan wages • Low wages disincentivize weavers to produce high quality work • Inability of consumers to appreciate as well as identify genuine handmade products, and hence pay commensurate prices	Visual display to establish product differentiation, provenance tracking, payment tracking, identification of handloom vs. power loom products, technologies to display the arts and crafts, and precise mapping of authenticity of Pashmina with BIS and global standards	1. Physically Unclonable QR Codes for each product, to establish authenticity and eliminate counterfeits. 2. IoT devices deployed on handlooms to capture the motion and further differentiate between a handmade and a machine-made product. 3. Optical scanner with Machine Vision capabilities to detect knots per inch in a carpet/shawl	1. IoT Devices were able to capture the motion of the traditional handloom as well as the upgraded handloom. 2. Optical scanner was able to capture the per inch knottage. 3. The above information was readily integrated with a web-based platform to make it user accessible.	The Directorate can adopt technologies which can authenticate the handmade shawls and carpets faster using machine vision technology thus eliminating the long-drawn testing processes for certification. The administration can explore integrating the IoT devices for tracking productivity. These are ready to deploy solutions which enables faster adoption. The accuracy of the devices would increase by training the devices with multiple products and with every use of the technology.

Strategic Context Factor	Functional Requirement	Idealised Capability Requirement	Capabilities Indicated in Field Technology Showcase	Course of Action
Diminishing inter-generational transfer of artistry skills and diminishing market for genuine handmade products resulting in 'languishing crafts': •Languishing Skill Base – undermines value creation & revenue generation •Inability to preserve the heritage knowledge and skills of the ageing master artisans •Inability of consumers to appreciate as well as identify genuine handmade products, and hence pay commensurate prices which reduces returns for the artisans	Augmenting the production process to create immersive experiences, digitizing the handicrafts and handloom production processes, creating digital knowledge and design banks, visually documenting the crafts and their intricacies, developing online training courses for artisans, creating a digital archive of traditional artistry skills, and supporting research and development in traditional artistry	1. An OCR model to digitise Taleems. Data collection, annotation, image pre-processing, and utilizing Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), specifically the Long Short-Term Memory (LSTM) architecture, for digitizing Taleem image content. 2. A deep learning algorithm to convert carpet images into design representations, leveraging generative AI and super resolution technology. 3. Various sensors, cameras and XR to capture and preserve traditional skills through immersive experiences, to facilitate skill enhancement, knowledge transfer, and the continuity of cultural heritage 4. Immersive experiences that showcase the crafts(wo)manship, quality, and cultural significance of	1. The OCR model was able to identify and process initial data sets fed into it. The software will need more data sets and customisation to be able to process designs into taleems. 2. Various cameras and other sensors were able to capture and record the manufacturing process and map the intricacies involved in each step. 3. LIDAR scanners were able to create 3D images of finished products. 4. Immersive experiences were created for: 4.1 Manufacturing processes 4.2 Digital Museum for display of finished products 4.3 Narrative technologies to capture the artisans' stories 4.4 Metaverse and online shopping experience for end customers	The Directorate can leverage the mixed reality technologies to create an immersive experience for the audience and consumers by deploying the technology in the Museum. The administration can explore creation of digital skilling solutions using the VR & AR technologies to enable training of the artisans. The mixed reality solutions can be well integrated with the QR codes to create a premium experience. The administration, exporters and manufacturers can deploy mixed reality solutions consumer purchase outlets including emporiums, airports, trade fares etc. The technology can be very well integrated with ecommerce platforms.

Strategic Context Factor	Functional Requirement	Idealised Capability Requirement	Capabilities Indicated in Field Technology Showcase	Course of Action
		handmade items to elevate the perceived value, exclusivity, and desirability of the products	The users were able to have a holistic immersive experience and understand the various steps involved in the manufacturing of products with the feature of buying the products from within the immersion	
Machinery and processes have not been upgraded or retrofitted in decades. Limiting the ability to compete in global markets: • Lack of machinery Upgradation • Need for semi-mechanisation of machinery • High turnaround times	Need for assistive technologies for the artisans and retrofitting machinery while retaining the "hand" in both the craft and loom	1. Micro Level wool processing units for deployment a cluster scale 2. Mechanised rollers for Namda manufacturing which make the process less labour intensive 3. Motorised versions of charkhas for spinning of fiber	1. The proposed mechanised equipment will enhance productivity and decrease the manual labour load on artisans and weavers.	The administration can leverage the ready to deploy semi-mechanised tools to increase the productivity and improve the quality. The administration can opt for technology transfer from the research and development institutes and RuTAGs. The administration can explore the possibility and relevant mechanisms to codevelop customised technologies in order to reduce artisan drudgery while improving the quality as per the global standards. This includes semi-mechanization of the

Strategic Context Factor	Functional Requirement	Idealised Capability Requirement	Capabilities Indicated in Field Technology Showcase	Course of Action
				processes and development of ergonomic tools and machinery which provides comfort and dignity to the artisans and at the same time retains the essence of handmade products
Ensuring product and process sustainability is a challenge: • Unavailability of organic and sustainable dyes for Pashmina and Wool carpets • Lack of effluent management	Need for low-cost sustainable/natural dyes, the use of local raw materials for manufacturing of dyes, and the development of an effluent management system	1. Using naturally sourced dyes 2. Deploying an effluent management system	1. Natural dyes were able to dye pashmina wool and retain the colour even after multiples washes. 2. Further collaboration is needed to source the dyes from local flora in Kashmir.	The administration can deploy the existing sustainable dying technologies developed by the research and development institutes. The administration can commission research and development institutes, RuTAGs in partnership with its relevant allied agencies to conduct detailed research and development of natural dyes with local flora. In the intervening period the administration can explore deployment of effluent treatment solutions.

Interactive Experience Section: Catalyzing Re-premiumization

QR code system deployed by the Directorate of Handicrafts & Handloom, Kashmir

Strengthening the QR code system with IoT based authentication and tracking devices

Interactive Experience Section:
Reducing Drudgery, Enhancing Productivity

Drudgery: Manual pressing of the felt by artisans

Supporting the artisans with semi-mechanised rollers for pressing the felt

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