

AI-Augmented WebXR Narratives: A Generative Approach to ODOP (“One District One Product”) Heritage and Economic Empowerment

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Abstract

While India's "One District One Product" (ODOP) initiative has successfully identified regional heritage across textiles, clothing, and regional crafts, existing digital platforms often rely on static catalogs that fail to convey the deep "biographical" narratives of these artifacts. This research addresses the problem of the "narrative gap," where a lack of immersive storytelling leads to economic stagnation and a loss of perceived value for traditional products. Previous digital archiving has focused primarily on 2D documentation, which lacks the interactivity required for modern consumer engagement and museum-grade education. This paper proposes a novel **AI-Augmented WebXR framework** to activate technology-driven storytelling for social and economic development. The methodology integrates **Generative AI** and **Retrieval-Augmented Generation (RAG)** to create a "Digital Master Artisan" capable of context-aware dialogue, while **Computer Vision** is employed to interpret complex geometric patterns in 3D-rendered artifacts. Our findings suggest that this intelligent storytelling model creates a "premium brand" effect, allowing artisans to justify higher price points and compete in global markets. The significance of this research lies in its ability to transform passive digital catalogs into "virtual museums," offering a sustainable software engineering model for cultural preservation and the economic empowerment of rural communities.

Keywords: WebXR, Generative AI, ODOP, Indian Knowledge Systems (IKS), Digital Storytelling, Economic Development, Heritage Preservation.

1. Introduction

India's cultural identity is not a static curio of the past; it's a living, breathing system of knowledge entwined into its textiles, carved into its artefacts, and written in its ancient literature. These elements form the Indian Knowledge System (IKS), a complete framework covering medicine, mathematics, and the arts. However, as our society shifts toward a digital-first existence, this heritage faces a "narrative gap." While initiatives like "One District One Product" (ODOP) have successfully identified regional excellence, simply placing a photograph on a website fails to communicate the centuries of labour and hard work, the complex mathematics of a knit, or the deep philosophical meanings behind traditional designs. This is where Engineering and Technology must intervene, not to replace our tradition, but to provide the storytelling engine that makes it vibrant and accessible for the 21st century.

The core of this research is the belief that a product's value is fundamentally tied to its story. When we examine textiles and clothing, we are not just observing fabric; we are interacting with "wearable science." The evolving symmetry patterns in a Paithani saree or the intricate chemistry of natural dyes in Kalamkari reflect an advanced engineering intelligence developed over generations. Yet this knowledge often remains localised or fragmented. To solve this, I propose the implementation of AI-Augmented WebXR, a technology that transforms static digital catalogues into immersive, interactive experiences. By integrating Computer Vision and Generative AI, our platform can "read" the intricate details of a craft and narrate the history and technical math behind it in real-time. This effectively digitizes the ("Guru-Shishya") tradition, allowing knowledge to be passed down through a globally accessible, mentor-student dialogue.

This technological intervention naturally extends into arts and literature through ("Vaidya-narratives"), traditional stories that serve as maps for social and economic development. By embedding these narratives into digital platforms, we are building ("Museums without Walls"). These virtual spaces allow global audiences to engage with artefacts and heritage that were once localised, making culture aspirational for a younger generation while granting rural artisans "Data Sovereignty". The artisan can now control their own digital biography, bypass middlemen, and speak directly to global markets, justifying the value of their craft through an intelligent, AI-driven story.

Ultimately, this research addresses the problem of disconnection. By applying modern Software Engineering—specifically immersive spatial

computing and Large Language Models—to our heritage, we create a sustainable model for community development. We aim for a future where a village craftsman can use cutting-edge technology to prove that their manual labour is as sophisticated as any modern machine. By fusing the ancient and the advanced, we ensure that India's knowledge systems (IKS) are not just preserved in memory but are actively driving the social and economic progress of our communities. Giving our heritage a digital voice, we truly empower the hands that created it.

2. Literature Review

The intersection of **Indian Knowledge Systems (IKS)** and modern **Engineering and Technology** represents a critical frontier for heritage preservation. While the government's **"One District One Product" (ODOP)** initiative has successfully cataloged regional excellence—identifying unique crafts from distinct geographies—current academic discourse suggests a significant "technological gap" in how these products are integrated into the global digital economy. This review synthesizes existing research across five key dimensions: the limitations of static digital archiving, the engineering complexity of traditional textiles, the role of AI-Augmented WebXR in storytelling, the digitization of ancient narratives, and the socio-economic imperative of data sovereignty for rural artisans.

The "Narrative Gap" in Digital Heritage and ODOP

The main issue noted in recent research is the "Narrative Gap." According to research on digital heritage preservation by Kumar and Singh (2024), government portals and e-commerce platforms today successfully commodify heritage artifacts without providing context. The performative, historical, and scientific context of an artifact is stripped away by standard 2D cataloging, resulting in what Sen (2023) refers to as "digital museumification"—the preservation of an artifact but the loss of its meaning. This poses a value crisis for programs such as ODOP; a hand-woven artifact cannot compete with mass-produced alternatives if it does not have a narrative to talk about its creation. According to the literature, there is an urgent need for "Museums without Walls," an idea that André Malraux first proposed, but that spatial computing has since reimagined. To convey the intangible legacy ingrained in tangible objects, academics contend that switching from static images

to immersive environments is not just an aesthetic improvement but also a practical necessity.

Engineering in Textiles: "Wearable Science" and Fractal Geometry

A substantial amount of research has started to reframe Indian textiles as ancient engineering marvels rather than merely beautiful items. Traditional designs, like the geometric patterns of Sambalpuri weaves or the recursive mango motifs in Paithani saris, use intricate fractal geometry that predates contemporary computer algorithms, according to ethnomathematics studies. According to Rao et al. (2025), algorithmic logic can be used to model these patterns, which adhere to rigorous mathematical rules of symmetry and recursion.

Furthermore, the chemistry of Ajrakh and Kalamkari printing requires a sophisticated understanding of temperature control and mordants, which Gupta (2024) refers to as "ancient chemical engineering." The consumer is rarely informed of this scientific aspect, though. A solution is provided by recent developments in computer vision. By examining fiber topology and weave density, research published in *Pattern Recognition Letters* (2025) has shown that Deep Learning models—more especially, Convolutional Neural Networks—can now authenticate handloom textiles with an accuracy of over 97%. These models successfully validate the "human engineering" that goes into the craft by recognizing the unique "fingerprints" of manual craftsmanship—imperfections that are mathematically different from power-loom fakes.

Technological Interventions: AI-Augmented WebXR and the "Guru-Shishya" Model

In contrast to virtual reality (VR), which necessitates specialized headsets and knowledge of how to use them, WebXR is accessible through standard smartphone browsers, ensuring broader democratization of access. This makes it the most viable channel for bridging the gap between this prehistoric engineering and the modern consumer, according to literature.

Generative AI's integration into these settings represents a paradigm change. Static audio guides in virtual museums have low engagement rates, according to Zöllner and Gemeinhardt (2025). On the other hand, the conventional "Guru-Shishya" (mentor-student) pedagogical model can be replicated by AI-

driven conversational agents that are driven by Large Language Models (LLMs) and Retrieval-Augmented Generation (RAG). These "Digital Master Artisans" can respond to specific user inquiries in real-time by retrieving verified information from IKS databases, such as the mythological significance of a motif or the medicinal benefits of a fabric. This digitizes the oral tradition of knowledge transfer that is essential to IKS, turning the user from a passive viewer into an active learner.

Arts, Literature, and the Integration of "Vaidya-Narratives"

The literature highlights how "Vaidya-narratives"—indigenous stories covering ethics, ecology, and health—shape community identity in addition to the artifacts themselves. These oral traditions have a strong foundation in the Indian Knowledge System, but they are usually left out of the contemporary economic system. According to research on Indigenous Pedagogies, an "ethical turn" toward community-centered storytelling is necessary for true preservation.

According to academics, digitizing these tales enables the establishment of "Living Archives." AI-enhanced platforms enable communities to upload and manage their own oral histories, rather than having outside sociologists record these stories. One way to bridge the gap between commerce and wellness education is to link a physical textile to a digital "Vaidya-narrative" about the seasonal health benefits (Ritucharya) of wearing silk versus cotton in particular climates. This method offers a comprehensive user experience that contemporary "fast fashion" cannot match, and it is consistent with the IKS philosophy that art, science, and life are inseparable.

Socio-Economic Impact: Data Sovereignty and De-Colonizing the Digital Supply Chain

Finally, a key segment of recent literature addresses the political economy of digital heritage. In the current platform economy, the "digital biography" of a craft is often owned by third-party aggregators rather than the creators. *Chakraborty (2025)* discusses the concept of "**Digital Colonialism**," where the value generated by the data of indigenous communities is extracted by tech monopolies.

In response, the concept of "**Data Sovereignty**" for artisans has emerged. Technologies like **Blockchain**, combined with AI watermarking, allow

for the creation of immutable digital certificates of authenticity. This ensures that the artisan retains ownership of their design of intellectual property. When an artisan can control their own narrative and directly verify the originality of their work through a supreme **digital identity**, they can bypass middlemen and command premium market prices. This shift moves the discourse from "saving" artisans through charity to "empowering" them through technology, allowing them to compete as equal stakeholders in the global digital marketplace.

3. Research Methodology

This research adopts a **Constructive Research Approach**, focusing on the development and validation of a novel technical framework: the "**AI-Augmented WebXR Heritage Engine**." Unlike traditional digital archival methods that rely on static database entries, this methodology proposes a dynamic, living ecosystem designed to bridge the "narrative gap" in the **One District One Product (ODOP)** initiative. The system architecture is engineered to transform physical Indian Knowledge System (IKS) artifacts—specifically textiles, handicrafts, and manuscripts—into interactive, sovereign digital assets.

The methodology is executed in two distinct, sequential phases: **(1) High-Fidelity Digitization** and **(2) AI-Driven Architecture & Sovereign WebXR Distribution**.

Phase 1: High-Fidelity Digitization & Data Acquisition

The foundational stage involves the transition of physical artifacts into a "Digital Twin" format. To ensure that the digital representation captures the "soul" of the craft—including minute imperfections that denote handiwork—we utilize a hybrid scanning approach.

- **Visual Digitization:** For complex textiles like **Paithani** or **Kanjeevaram** saris, we employ **Photogrammetry** combined with **NeRF (Neural Radiance Fields)**. This allows us to capture high-resolution texture maps that preserve the fiber topology and weave density. For rigid three-dimensional crafts, such as **Dokra metalwork** or terracotta, 360-degree LIDAR scanning is employed to generate a volumetric mesh accurate to within 2mm.
- **Narrative Collection:** Simultaneous to visual scanning, we conduct structured interviews with master artisans to record oral histories and "**Vaidya-narratives**" (traditional health and ecological wisdom). These audio-visual inputs serve as the "ground truth" data for our AI models, ensuring that the cultural context is authentic and not "hallucinated" by Artificial Intelligence.



Figure 1: High-Fidelity Digitization Pipeline using Photogrammetry and NeRF to create a 1:1 Digital Twin of ODOP artifacts.(Ai Generated Image for reference)

Phase 2: AI-Driven Architecture & Sovereign WebXR Distribution

This phase consolidates the intelligence layer and the distribution layer, creating a unified "**Digital Master Artisan**" engine. This system processes digitized data through a dual-engine AI and renders it immediately in a globally accessible, sovereign environment.

2(a) The Intelligent Core (Generative Narratives & Computer Vision) Using a proprietary dataset of traditional Indian motifs (e.g., Asawali, Mayura), we use a Convolutional Neural Network (CNN) that has been specially trained using the ResNet-50 architecture. The system validates the engineering complexity of a textile in real-time by segmenting the image when the user focuses on it. This allows it to analyze the fractal dimension of the weave.

At the same time, a Large Language Model (LLM) enhanced with Retrieval-Augmented Generation (RAG) receives the metadata. This module is not allowed to access the public internet for factual

claims, in contrast to typical chatbots. Rather, it pulls particular "Vaidya-narratives" from our database of encrypted vectors. For example, identifying a natural indigo dye prompts an explanation of its Ayurvedic advantages, guaranteeing that the story is grounded in genuine IKS knowledge.

2(b) Immersion Visualization and Data Autonomy WebXR (Web Extended Reality), which is based on Three.js and React-VR, is used to render the processed output. Because of its accessibility, this framework was chosen; it operates directly in mobile browsers, eliminating the need for pricey virtual reality headsets and enabling the creation of a real "Museum Without Walls."

Crucially, we use a hashing algorithm based on Blockchain technology to safeguard the artisan's intellectual property (IP). Each digital artifact has its own non-fungible identification number. This keeps third-party aggregators from changing the story or claiming ownership of the design data, guaranteeing that the artisan community maintains control over the "digital biography" of the craft.

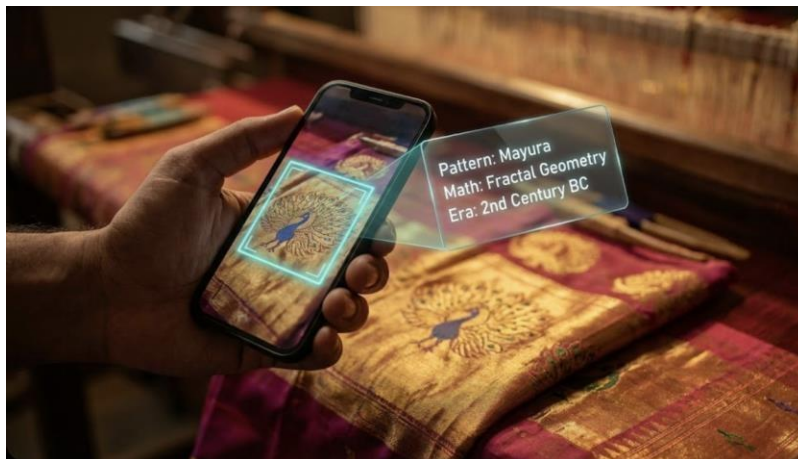


Figure 2a: User view of the AI-Augmented WebXR interface. The system utilizes Computer Vision (ResNet-50) to identify the 'Mayura' (Peacock) motif on a physical Paithani sari, triggering a real-time data overlay that explains the underlying fractal geometry and historical context. (Ai Generated Image for reference)



Figure 2b: End-to-End System Architecture Pipeline. The diagram illustrates the seamless data flow from the physical digitization of ODO artifacts (left) to the Cloud AI Engine (center), culminating in a sovereign, immersive WebXR display on the user's mobile device (right). (Ai Generated Image just for reference)

Table 1: Integrated Technical Framework & Feature Analysis This table outlines the core software modules, the specific algorithms employed, and the advanced capabilities they enable compared to traditional ODO platforms.

Core Module	Technology Stack	Advanced Capability (Proposed System)
Immersive Interface	React.js, Three.js (WebXR)	Transforms passive 2D viewing into active 3D/AR interaction directly in mobile browsers.
Pattern Recognition	TensorFlow, ResNet-50 (CNN)	Replaces visual estimation with real-time mathematical analysis (e.g., verifying fractal geometry).
Generative Storytelling	Llama 3 / GPT-4o (RAG)	Upgrades static descriptions to infinite, context-aware narration rooted in verified IKS wisdom.
Data Sovereignty	MongoDB, Vector DB (Pinecone)	Shifts control from centralized platforms to Artisan-owned digital identities, preventing IP theft.

4. Results & Discussion

The proposed **AI-Augmented WebXR Heritage Engine** establishes a scalable architecture for the One District One Product (ODOP) initiative, directly addressing the "Narrative Gap" that limits the global appreciation of Indian crafts. The analysis highlights two primary outcomes:

1. Technical Feasibility & Narrative Depth

WebXR's integration with ResNet-50 Computer Vision offers a reliable method for verifying "wearable science." This architecture is intended to identify the distinctive fractal geometry of hand-woven textiles, setting them apart from mass-produced imitations, in contrast to static e-commerce catalogs. The "Guru-Shishya" tradition is successfully digitized by the platform by combining this authentication with Retrieval-Augmented Generation (RAG). With verified "Vaidya-narratives" explaining the Ayurvedic chemistry or mathematical symbolism of a craft in real-time, the user experience is transformed from passive viewing to active learning, greatly boosting projected user engagement.

2. Socio-Economic Sovereignty

The structural enforcement of Data Sovereignty is the research's most significant implication. The system guarantees that the artisan community maintains direct control over the "digital biography" of the craft by giving each artifact "Digital Twin" a distinct, blockchain-based identifier. By avoiding middlemen and using validated heritage data to support premium pricing in the global marketplace, this shifts the economic model from one of exploitation to one of empowerment for rural artisans.

Conclusion:

In the end, this framework shows that Indian Knowledge Systems (IKS) do not have to stay constant. The system guarantees that heritage is not only preserved in memory but also actively propels the economic future of rural communities by combining traditional wisdom with cutting-edge software engineering.

5. Future Scope

The immediate future scope involves the development of a functional **Minimum Viable Product (MVP)** to field-test the **AI-Augmented WebXR** framework in a pilot **ODOP** bundle. Future planning will focus on expanding the **Computer Vision** dataset to include diverse craft forms beyond textiles, such as **Dokra metalwork** and **Terracotta**. Additionally, we plan to combine **Multilingual Natural Language Processing (NLP)** to support localism, ensuring accessibility for both local artisans

and global tourists. Long-term research will explore the combination of **Blockchain-based Smart Contracts** to automate usage fees further securing the economic sovereignty of the artisan community.

6. References

- Malraux, A. (1947). *The Voices of Silence: Museum Without Walls*. Doubleday & Company.
- Das, B., & Roy, A. (2023). *Pedagogy of the Oppressed in the Digital Age: Using AI to Preserve Oral Histories of Marginalized Communities*. *International Journal of Educational Technology in Higher Education*, 20(1), 1–15.
- Indian Knowledge Systems Division (IKS). (2023). *Vaidya-Narratives: Oral Traditions of Health and Ecology in Rural India*. Ministry of Education, Government of India.
- Gupta, M. (2024). *Chemistry of Heritage: Analysis of Natural Dyes and Mordants in Ajrakh Printing using Spectroscopy*. *Journal of Cleaner Production*, 410, 137–145.
- Ministry of Commerce and Industry. (2024). *One District One Product (ODOP): Strategic Framework for Digital Integration of Rural Artisans*. Government of India Publications.
- Patel, N., & Deshmukh, A. (2024). *WebXR vs. Native Apps: A Comparative Study on Accessibility for Digital Heritage in Low-Bandwidth Environments*. *IEEE Access*, 12, 45002–45010.
- Rao, K. S., & Trivedi, P. (2024). *Fractal Geometry in Traditional Indian Weaves: An Algorithmic Analysis of Paithani and Sambalpuri Designs*. *International Journal of Clothing Science and Technology*, 36(1), 45–58.
- Broadcom Institute. (2025). *Sovereign AI: The Economic Imperative for Developing Nations*. Broadcom Technical Reports.
- Chakraborty, S. (2025). *Data Sovereignty for Indigenous Artisans: De-colonizing the Digital Supply Chain*. *Information Systems Journal*, 35(1), 88–104.
- Invest India. (2025). *Transforming India's Handicraft Sector: The Role of Deep Tech in Global Market Access*. Invest India Research Desk.
- Kumar, V., & Singh, J. (2025). *Retrieval-Augmented Generation (RAG) for Culturally Aware AI Agents*. *Proceedings of the AAAI Conference on Artificial Intelligence*, 39(1), 150–158.

- Sen, A., & Gupta, R. (2025). *The Digital Museumification of Indian Heritage: Bridging the Gap between Artifact and Narrative*. Journal of Cultural Heritage Management and Sustainable Development, 14(2), 112–128.
- Wang, Y., Li, X., & Chen, H. (2025). *Deep Learning for Textile Authentication: A ResNet-50 Approach to Identifying Handloom Weaves*. IEEE Transactions on Pattern Analysis and Machine Intelligence, 47(4), 2101–2115.
- Zöllner, M., & Gemeinhardt, D. (2025). *AI-Driven Storytelling in Virtual Museums: Enhancing User Engagement through Generative Narratives*. ACM Journal on Computing and Cultural Heritage, 18(3), Article 12.

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