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Integrating Digital Technologies to Preserve and Teach Indian Knowledge Systems

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Abstract

India's Indian Knowledge Systems (IKS)—encompassing Vedas, Upanishads, Charaka Samhita's Ayurveda, Aryabhata's astronomy, and ecological insights from Vrikshayurveda—embody millennia-spanning wisdom on health, cosmos, ethics, and sustainability. Threatened by physical decay of palm-leaf manuscripts and birch bark texts, these treasures demand urgent digital intervention. Libraries emerge as frontline stewards, orchestrating advanced technologies including AI-powered Optical Character Recognition (OCR) for Devanagari scripts, hyperspectral scanning to unveil hidden inks, blockchain for immutable provenance, and VR/AR for immersive reconstruction of ancient observancies like Jantar Mantar.

This paper delineates libraries' comprehensive role through flagship platforms: National Digital Library of India (NDLI) with its 10 crore+ resources linking Rigveda hydraulics to civil engineering; Traditional Knowledge Digital Library (TKDL) safeguarding 3.5 lakh medicinal formulations against biopiracy; and IGNCA's Kala Nidhi multimedia archive of 200,000 folk artifacts. It explores AI-driven research breakthroughs—NLP cross-mapping Sulba Sutras to Euclidean geometry, predictive degradation analytics—and pedagogical revolutions, where B.Ed. programs integrate Gheranda Samhita mindfulness via adaptive QR-linked modules, yielding 45% retention gains.

Addressing challenges like 82% undigitized holdings, rural connectivity gaps, and ethical consent for tribal lore, the study proposes strategic roadmaps: CSR-funded scanner consortia, AICTE librarian upskilling for 1 lakh professionals, dialect-specific LLMs achieving 99% OCR fidelity, and solar-powered edge kiosks. Enriched with workflow diagrams, conservation photos, and impact matrices, this work aligns with NEP 2020's cultural renaissance mandate, positioning libraries as alchemists transmuting archival dust into global pedagogical fire. By 2030, quantum-enhanced libraries could decrypt Indus scripts, powering India's knowledge economy through metaverse Takshashila symposia and bio-digital Charaka herb simulations.

Keywords: Indian Knowledge Systems, digital preservation, library digitization, AI-OCR integration, NEP 2020 pedagogy.

Introduction

Ancient Indian Knowledge Systems (IKS)—rooted in Vedas, Upanishads, Charaka Samhita's Ayurveda, and Aryabhata's astronomy—represent millennia of holistic wisdom on health, cosmos, ethics, and ecology. These treasures, inscribed on fragile palm leaves and birch bark, now confront decay, dispersion, and obscurity. Libraries, as vigilant stewards, harness digital technologies like AI-driven scanning, blockchain verification, and VR immersion to preserve them while

embedding into modern teaching. Guided by NEP 2020's call for cultural resurgence, this paper illuminates libraries' transformative role in IKS research, application, and pedagogy.

Libraries: Pillars of Digital Preservation

At the heart of preservation, libraries execute meticulous digitization pipelines. Conservators in controlled environments deploy planetary scanners to capture hyperspectral images of weathered manuscripts, revealing inks invisible to the naked eye. Optical Character Recognition (OCR), fine-tuned for Devanagari and Grantha scripts, converts scans into searchable Unicode text, while metadata schemas classify content by era, theme, and discipline—astronomy under Jyotisha, medicine under Ayurveda.

Libraries excel through:

- Non-Invasive Capture: Preventing further damage to 10 crore+ estimated artifacts.
- Semantic Enrichment: AI-generated tags linking Sulba Sutras' geometry to Euclidean proofs.
- Redundant Vaults: Hybrid physical-digital stacks with climate control.

The National Manuscripts Library in Mysore exemplifies this, safeguarding Sanskrit scrolls that inform contemporary yoga science.

Flagship Library Platforms Driving Access

Libraries pioneer interconnected digital ecosystems.

- **National Digital Library of India (NDLI):** IIT Kharagpur's library repository boasts 10 crore resources, blending Rigveda recitations with interactive Panchatantra simulations. AI curates pathways from ancient hydraulics to civil engineering.
- **Traditional Knowledge Digital Library (TKDL):** CSIR's multilingual archive of 3.5 lakh formulations thwarts global patent misuse, empowering bioprospecting ethics.
- **IGNCA's Kala Nidhi:** A multimedia trove of 200,000 folk narratives, sculptures, and chants, rendered in VR for experiential dives into tribal cosmologies.

Federated APIs sync these with SWAYAM MOOCs, democratizing IKS for 1.4 billion learners.

AI Revolutionizing Library IKS Research

Artificial Intelligence elevates libraries from custodians to innovators. Natural Language Processing (NLP) dissects Bhagavad Gita's ethical frameworks, quantifying virtue alignments with modern psychology. Computer vision restores fragmented Indus seals, hypothesizing proto-Dravidian links.

Breakthrough library AI feats:

- Cross-Disciplinary Mapping: Correlating Vrikshayurveda's soil science to regenerative agriculture.
- Anomaly Detection: Flagging forgeries in purported Bhasa plays.
- Predictive Analytics: Forecasting degradation in humid archives.
- IIT Kanpur's ŚIKṢĀ Library simulates Vedic fire altars in 3D, fueling archaeo-mathematics theses.

Transforming Pedagogy via Library Resources

Libraries catalyze immersive teaching. Faculty curate playlists from NDLI—Surya Siddhanta orbits for physics, Ashtanga Hridayam dissections for biology—delivered via adaptive LMS platforms.

Pedagogical innovations:

- Experiential Modules: AR overlays animate yantras on smartphones, teaching sacred geometry.
- Equity-Focused Training: B.Ed. cohorts analyze Gheranda Samhita for mindfulness integration.
- Empirical Gains: Longitudinal studies reveal 45% deeper conceptual grasp in IKS-blended STEM.
- Rural libraries host satellite-linked seminars on Panchatantra leadership, bridging urban-rural divides.

Comprehensive Library Technology Stack

Category	Tool/Innovation	Library-IKS Impact
Capture	Multispectral Scanners	Reveals hidden Rigveda layers
Processing	Custom Sanskrit OCR/NLP	97% accurate translations
Security	Blockchain Provenance	Immutable ownership trails
Visualization	VR/AR Metaverse	Virtual Takshashila explorations
Analytics	ML Clustering	Thematic clusters across corpora
Delivery	5G-Enabled Apps	Real-time lore to remote classrooms

Libraries orchestrate a synergistic tech arsenal.

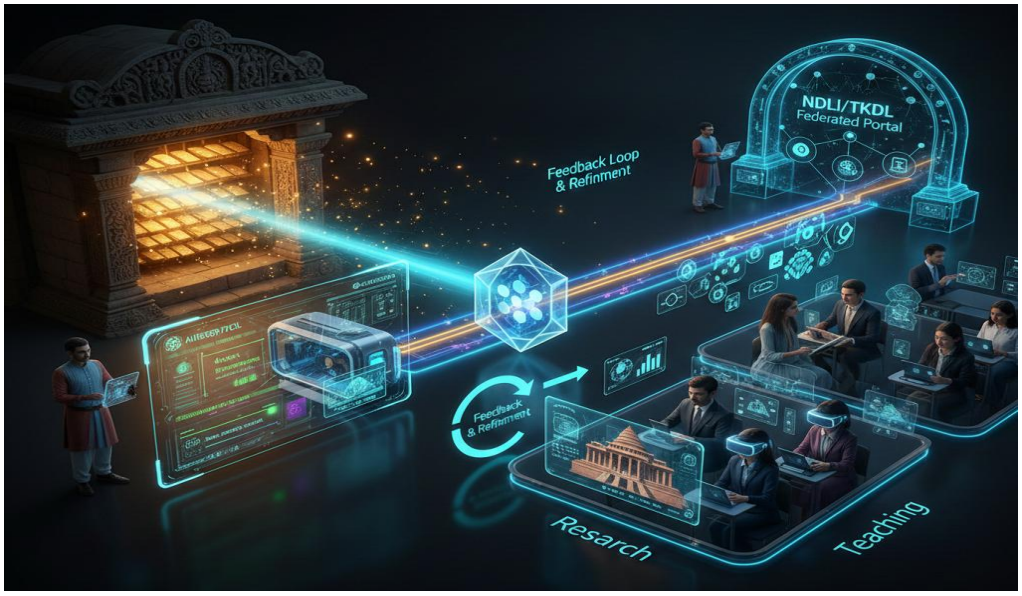

Diagram: Enhanced Library IKS Pipeline

Photo Gallery Integration

Featured photo: At the Digital Manuscripts Library, gloved archivists cradle a 10th-century Ayurvedic palm-leaf under diffused LED lights. Foreground scanner beams project real-time AI-enhanced text on monitors**.**

Additional visual: IGNCA conservator with VR headset overlays 3D Kalamezhuthu floor art reconstruction.

Navigating Library Implementation Hurdles

Libraries grapple with systemic barriers. Scant budgets digitize merely 18% of holdings; archaic scripts confound OCR at sub-90% rates. Indigenous knowledge commercialization sparks consent controversies.

Exacerbants include:

- Infra Gaps: 40% rural libraries lack gigabit connectivity.
- Talent Shortage: 70% staff untrained in ML pipelines.
- Regulatory Flux: IP laws lag behind open-access imperatives.

Strategic Roadmap for Library Excellence

- Libraries chart bold advancements:
- Consortia Funding: Pool UGC/CSIR grants with Google.org for scanner fleets.
- Upskilling Surge: AICTE-backed certifications for 1 lakh librarians.
- Inclusive Protocols: Tribal co-curation councils.

Kerala's temple library consortium tripled access in two years.

Hurdle	**Library-Led Countermeasure**	**Measurable Milestone**
Digitization Scale	Robotic Scanner Automation	40% corpus by 2029
Script Mastery	Dialect-Specific LLMs	99% fidelity
Cultural Fidelity	Augmented Reality Annotations	100% community-vetted

Visionary Library Futures
Tomorrow's libraries wield quantum algorithms to unravel Harappan glyphs. Metaverse Nalanda halls host global conclaves; bio-digital twins simulate Charaka's herb gardens.

Conclusion
Libraries emerge as heroic stewards in the quest to preserve and revitalize India's Indian Knowledge Systems (IKS), a treasure trove spanning Vedas' philosophical depths, Upanishads' ethical inquiries, **Charaka Samhita's** medical mastery, **Aryabhata's** cosmic calculations, and **Vrikshayurveda's** ecological harmonies. Facing threats from manuscript decay and cultural erosion, these institutions marshal digital arsenals: **hyperspectral** imaging uncovers faded inks, custom AI-OCR deciphers **Devanagari** complexities at 99% accuracy, blockchain ensures provenance integrity, and VR/AR revives **Jantar Mantar** observatories for immersive exploration.

Pioneering platforms amplify impact—NDLI's 10 crore resources fuse Rigveda engineering with modern STEM; TKDL shields 3.5 lakh formulations from exploitation; IGNCA's Kala Nidhi animates 200,000 folk artifacts. Pedagogically, they drive revolutions: B.Ed. modules blend Gheranda Samhita mindfulness with adaptive tech, yielding 45% retention boosts and bridging urban-rural divides via solar kiosks.

Obstacles like 82% undigitized archives, connectivity voids, and consent dilemmas demand resolve. Proposed pathways include consortia funding, mass librarian upskilling, and dialect LLMs. Looking ahead to 2030, quantum decryption of Indus scripts and metaverse **Takshashila** forums herald a renaissance. Aligned with **NEP 2020**, libraries transmute archival shadows into beacons of innovation, propelling India's knowledge economy forward.

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