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Article

The Internal Logic and Path Exploration of Hainan Li-Miao Culture Driving Rural Industrial Revitalization under the Perspective of Digital Intelligence Empowerment

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Abstract: This study investigates how the internal logic of Hainan Li-Miao cultural systems—rooted in ecological knowledge, ritualized land stewardship, and intergenerational craft transmission—can be strategically activated to drive rural industrial revitalization under digital intelligence empowerment. Moving beyond technocentric adoption models, the research identifies three core cultural logics: (1) cyclical reciprocity between human practice and natural systems, (2) embedded governance through kinship-anchored collective decision-making, and (3) symbolic-material continuity wherein intangible heritage directly sustains tangible production chains. Through participatory fieldwork across 12 Li-Miao villages, mixed-method analysis reveals that digitally mediated interventions succeed only when they amplify—not replace—these logics: for instance, blockchain traceability gains legitimacy only when mapped onto existing lineage-based accountability structures; AI-assisted textile pattern generation is adopted only when trained on motifs validated by elder weavers' semantic classification; and smart agriculture platforms are scaled only when integrated with lunar-calendar planting rhythms codified in oral chants. The path exploration yields a tripartite framework: cultural resonance alignment, institutional scaffolding, and value-chain anchoring. Findings challenge linear 'digital leapfrogging' assumptions and affirm that sustainable rural industrialization emerges not from external technological infusion, but from the intelligent reactivation of endogenous cultural architectures.

Keywords: cultural logic; rural revitalization; digital intelligence; indigenous knowledge; Li-Miao

1. Introduction

1.1. The Dual Imperative: Cultural Preservation and Industrial Viability

Hainan's Li-Miao communities confront a dual imperative: the urgent preservation of intangible cultural heritage—woven textiles, oral epics, ritual ecologies—and the structural imperatives of rural industrial viability. Decades of socioeconomic marginalization have intensified the erosion of intergenerational knowledge transmission while constraining market integration, value capture, and infrastructural resilience. Digital intelligence is not introduced here as a technocratic panacea but as a relational medium whose functional legitimacy hinges on epistemic fidelity to endogenous cultural logics and pre-existing social infrastructures [1]. Algorithmic systems, data architectures, and interface designs must be co-constituted with Li-Miao ontologies—not superimposed upon them [2]. This demands methodological humility: digital tools must scaffold rather than supplant communal decision-making protocols, align with seasonal and ritual temporalities, and respect embedded knowledge hierarchies. The central analytical pivot thus shifts from technological adoption metrics to relational calibration—how digital intelligence mediates, amplifies, or reconfigures existing cultural–economic feedback loops. Without such calibration, interventions risk reproducing extractive patterns under new technical guises. The path forward lies in treating digital intelligence not as an

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external accelerator but as a culturally intelligible interface for reactivating latent productive capacities within Li-Miao socio-technical ecosystems.

1.2. Beyond Techno-Solutionism: Defining Internal Logic

The concept of internal logic denotes the endogenous, self-sustaining configuration of principles that govern knowledge transmission, resource allocation, and value attribution within Li-Miao cultural systems. This logic is not reducible to instrumental efficiency or externally defined development indicators; rather, it emerges from historically sedimented practices of ecological stewardship, kinship-based governance, and ritualized epistemology. Digital intelligence tools—ranging from participatory mapping platforms to AI-assisted dialect preservation interfaces—do not operate in a vacuum but must interface with these pre-existing structures. Their efficacy hinges not on technological novelty alone but on fidelity to culturally embedded modes of consent, reciprocity, and intergenerational continuity. To impose algorithmic optimization without regard for such logics risks epistemic erasure and institutional dislocation. Therefore, digital empowerment must be conceived as a translational practice: one that calibrates technical affordances to the semantic weight, temporal rhythms, and relational grammar of Li-Miao lifeworlds [3]. This recalibration demands methodological humility, co-design protocols grounded in community epistemic authority, and metrics of success aligned with cultural resilience rather than mere output volume [4]. Such an orientation repositions technology not as a driver but as a mediator—amplifying, rather than replacing, the internal logic's generative capacity.

1.3. Scope and Conceptual Boundaries

This study is rigorously bounded to Li-Miao indigenous communities located within Baisha, Qiongzhong, and Wuzhishan counties of Hainan Province, explicitly excluding Han-majority rural areas and non-indigenous settlement contexts [3, 5]. The conceptual scope of "rural industrial revitalization" is narrowly defined as culturally embedded, small-scale production systems rooted in Li-Miao epistemologies and material practices [6, 7]. It encompasses three empirically anchored domains: traditional textile weaving utilizing natural dyes and loom-based techniques; localized processing of native herbal medicines guided by intergenerational knowledge transmission; and community-coordinated eco-tourism initiatives that integrate sacred geography, oral narrative, and participatory governance [2, 8]. Crucially, the analysis excludes export-oriented agro-industrial models, large-scale commercial agriculture, and standardized tourism infrastructure development. Digital intelligence empowerment is interpreted not as technological substitution but as a co-design process wherein algorithmic tools, spatial data platforms, and digital storytelling interfaces are calibrated to reinforce—rather than displace—existing cultural logics, kinship-based labor organization, and ecological stewardship frameworks. This boundary-setting ensures analytical fidelity to endogenous developmental pathways while enabling precise assessment of how digital mediation interacts with historically constituted modes of cultural reproduction and economic practice [9].

2. Literature Review

2.1. Indigenous Knowledge Systems and Economic Resilience

Indigenous knowledge systems constitute dynamic, place-embedded epistemic frameworks that sustain economic resilience through non-market mechanisms. These systems integrate ecological literacy—deep understanding of local biophysical thresholds and species interdependencies—with oral historiography that encodes adaptive responses to climatic variability and resource scarcity [2, 10]. Ritualized labor cycles further embed temporal coordination into socioecological rhythms, synchronizing production, conservation, and redistribution across seasons and generations. Such practices function not as static traditions but as iterative risk-mitigation protocols, where knowledge transmission occurs through embodied practice rather than formal instruction.

Intergenerational equity is structurally assured by design: resource access rules, seed-sharing norms, and rotational land-use protocols distribute entitlements across age cohorts and kinship networks, preventing capital concentration and buffering against external shocks [5, 11]. Under digital intelligence empowerment, these systems gain new articulation pathways—not through replacement, but via augmentation—where algorithmic tools map phenological patterns onto ancestral calendars or translate oral narratives into interoperable semantic ontologies. The critical challenge lies in preserving epistemic sovereignty while enabling syntactic interoperability with external data infrastructures. This demands architectures that privilege relational logic over extractive datafication, ensuring that digital mediation reinforces, rather than displaces, the embedded ethics of reciprocity, stewardship, and collective memory.

2.2. Digital Intelligence in Rural Contexts: Gaps and Assumptions

Contemporary rural digital intelligence initiatives frequently operate under implicit assumptions that undermine their contextual efficacy. Smart agriculture dashboards presume standardized data inputs and linear decision pathways, yet Li-Miao communities often rely on cyclical, seasonally embedded agronomic knowledge validated through intergenerational oral transmission rather than real-time sensor feeds. E-commerce platforms assume monolingual interface fluency and individualized transaction logic, neglecting multilingual information ecologies where Hlai, Miao, and Mandarin coexist in layered communicative registers and collective purchasing decisions emerge from clan-based consensus mechanisms. Remote education portals presuppose stable connectivity and asynchronous learning rhythms, disregarding intermittent infrastructure access and the primacy of synchronous, place-based pedagogical practices rooted in ritual timing and ecological observation [12]. These models further overlook non-linear knowledge validation—where empirical verification occurs not through algorithmic confidence scores but through communal deliberation, ancestral precedent, and embodied practice across generations. Consequently, technical solutions are often grafted onto preexisting social architectures without recalibrating for epistemic pluralism, temporal heterogeneity, or relational governance logics [13, 14]. Without recentering design around these foundational cultural logics, digital intelligence risks reproducing extractive patterns rather than enabling endogenous revitalization pathways.

2.3. Cultural Logic as Infrastructure: Bridging Theory and Practice

Cultural logic functions not as residual folklore but as operational infrastructure—comprising tacit protocols for communal consent, calibrated thresholds for environmental intervention, and embodied standards for quality assessment [15]. Within Hainan's Li-Miao communities, these logics manifest as intergenerational knowledge systems governing land stewardship, craft production, and ritual timing, all embedded in practice rather than codified doctrine. Digital intelligence systems deployed for rural industrial revitalization must interface directly with this infrastructure to achieve functional uptake and long-term sustainability. Failure to align algorithmic decision thresholds with locally validated ecological boundaries or to translate artisanal quality judgments into interoperable digital ontologies results in system rejection or performative adoption [16]. This section reframes cultural logic as a dynamic, rule-governed substrate: its variables include τ_{consent}, the temporal window for collective deliberation; $\delta_{\text{ecosystem}}$, the permissible deviation from traditional agro-ecological baselines; and σ_{craft}, the tolerance range for material variation accepted as authentic. Recognizing such parameters enables co-design frameworks where digital tools augment rather than overwrite indigenous epistemic authority.

3. Materials and Methods

3.1. Participatory Action Research Design

This study employed a participatory action research design structured across a 14-month iterative cycle spanning 12 Li- and Miao-majority villages in Hainan. The process

unfolded in three interdependent phases: co-identification of cultural logic anchors, co-development of digital prototypes, and co-evaluation using mixed legitimacy criteria. Cultural anchors included ritual practices such as mountain spirit consent ceremonies and bamboo harvesting aligned with lunar phase cycles. Digital prototypes were co-designed to embed these logics—specifically, a voice-narrated lunar calendar application and a lineage-verified craft certification portal leveraging blockchain for textile provenance. As detailed in Table 1, village selection prioritized ethnolinguistic homogeneity and documented craft continuity; prototype types included the voice-interface lunar calendar app and the blockchain-backed textile provenance ledger; co-evaluation metrics comprised elder validation rate (%) and youth adoption duration (weeks). Fieldwork was conducted by bilingual anthropologist-technologist teams trained in local epistemologies and agile prototyping. Each iteration integrated real-time feedback from community councils comprising elders, artisans, and youth representatives. Usage analytics were triangulated with semi-structured interviews assessing cultural resonance, procedural fidelity, and intergenerational transmission efficacy. Statistical thresholds for iterative refinement were set at $p < 0.001$ for usage metric divergence and ≥85% elder validation for cultural legitimacy. All digital tools underwent localized interface testing across dialect variants and literacy levels. This protocol ensured methodological rigor while sustaining epistemic sovereignty throughout the co-design continuum [12, 17].

Table 1. Fieldwork Parameters and Co-Design Protocol

Parameter	Value
Village Selection Criteria	Ethnolinguistic homogeneity and documented craft continuity
Digital Prototype Type	Voice-interface lunar calendar app; blockchain-backed textile provenance ledger
Co-Evaluation Metric	Elder validation rate (%) and youth adoption duration (weeks)

3.2. Cultural Logic Mapping Framework

A cultural logic mapping framework was developed to systematically extract and categorize the internal logics embedded in Hainan Li-Miao cultural practices. This qualitative coding schema was applied across three empirical data streams: 87 recorded oral narratives, 42 ritual observations, and 31 craft process interviews. Codes were iteratively refined through team-based axial coding until theoretical saturation was achieved. As detailed in Table 2, the framework organizes emergent patterns into three non-hierarchical but interlocking categories. Temporal logic captures how time is structured through cyclical markers—such as lunar-phase planting chants and seasonal migration songs—and their functional integration into digital agriculture workflows, exemplified by chants recited before sensor deployment in terraced fields [18, 19]. Relational logic documents how kinship structures govern access to ecological resources and knowledge transmission, including clan-specific forest access rights and elder-weaver mentorship lineages, with observed manifestations such as younger women being assigned dye-vat supervision only after formal recognition by clan matriarchs. Material-semiotic logic examines how tangible artifacts encode ecological intelligence: geometric textile patterns represent watershed boundaries, while bamboo node counts indicate soil moisture levels—evidenced by AI pattern generators being rejected during monsoon calibration when outputting dry-season motifs. The framework thus operationalizes culture not as static heritage but as a dynamic, context-sensitive logic system that interfaces with digital intelligence infrastructure. All coding procedures adhered to intercoder reliability thresholds exceeding $\kappa = 0.87$, with discrepancies resolved via consensus adjudication.

Table 2. Cultural Logic Coding Axes and Indicators

Logic Category	Indicator Examples	Observed Manifestation
Temporal Logic	Lunar-phase planting chants; seasonal migration songs	Chants recited before sensor deployment in terraced fields
Relational Logic	Clan-specific forest access rights; elder-weaver mentorship lineages	Younger women assigned dye-vat supervision only after formal recognition by clan matriarchs
Material-Semiotic Logic	Geometric textile patterns representing watershed boundaries; bamboo node counts indicating soil moisture levels	AI pattern generator rejected when outputting 'dry-season motifs' during monsoon calibration phase

3.3. Digital Interface Validation Protocol

The Digital Interface Validation Protocol implements a dual-layer evaluation framework to ensure both technical robustness and cultural fidelity. As detailed in Table 3, the Technical Functionality layer assesses latency under variable network loads, offline operation stability under 2G network conditions, and zero crash during 72-hour continuous use. The Cultural Resonance layer evaluates elder consensus on metaphor appropriateness using structured semantic differential scales, requiring ≥80% agreement on cosmologically grounded terms such as 'spirit cave archive' versus 'cloud server'. A third dimension—Youth Adoption—measures weekly active use sustained over eight weeks, with a pass threshold of ≥65% of the target cohort (ages 18–35) completing ≥3 core tasks per week [5]. Validation employed iterative mixed-method field trials across twelve Li-Miao villages, stratified by linguistic subgroup and digital access level. Technical metrics were captured via automated telemetry embedded in the interface SDK; cultural assessments utilized moderated focus groups led by village elders trained in ethnosemantic elicitation protocols. All statistical thresholds were pre-registered: $p < 0.001$ for inferential tests, Cohen's $d \geq 0.8$ for effect size benchmarks, and inter-rater reliability maintained at $\kappa \geq 0.75$ across coding teams [10, 17]. This protocol ensures empirical rigor while centering Indigenous epistemological frameworks as non-negotiable design constraints rather than post-hoc validation add-ons.

Table 3. Dual-Layer Validation Criteria

Layer	Criterion	Pass Threshold
Technical Functionality	Latency under variable network loads	< 200 ms (95th percentile)
Technical Functionality	Offline operation stability under 2G network conditions	≥ 99.2% task completion rate
Technical Functionality	Zero crash during 72-hour continuous use	0 crashes observed
Cultural Resonance	Elder consensus on metaphor appropriateness	≥80% agreement in structured semantic differential scale (e.g., 'spirit cave' vs. 'cloud server')
Youth Adoption	Weekly active use sustained over 8 weeks	≥65% of target cohort (ages 18–35) completing ≥3 core tasks/week

4. Results

4.1. Three Dominant Cultural Logics Identified

Empirical analysis across twelve Li-Miao villages reveals three dominant cultural logics structuring rural industrial revitalization under digital intelligence empowerment. First, Cyclical Reciprocity manifests as tightly coupled feedback systems wherein harvest timing, ritual offerings, and craft material sourcing operate as interdependent nodes—bamboo harvesting, for instance, is timed to post-monsoon sap flow and verified through

bark texture and bird call patterns. Second, Kinship-Embedded Governance governs resource access and knowledge transmission through clan affiliation: dye-vat access is restricted to women of specific matrilineal lines, and apprenticeship occurs exclusively during wet-season weaving camps. Third, Symbolic-Material Continuity encodes ecological intelligence in culturally salient forms—red textile motifs signal volcanic soil zones, while green motifs indicate limestone aquifer proximity, and chant lyrics embed phenological cues for herbal harvesting. As detailed in Table 4, these logics impose precise operational requirements on digital infrastructure: sensor networks must trigger alerts aligned with lunar-solar-biological triads rather than fixed calendar dates; blockchain permissions must mirror genealogical trees rather than individual accounts; and AI pattern generators must accept elder-annotated motif maps—not pixel datasets—as training ground truth. These findings demonstrate that effective digital intelligence integration does not override indigenous logic but must formally instantiate its structural constraints. The alignment between material practice and interface requirement underscores a foundational principle: technological design must be ontologically grounded in local epistemic frameworks to avoid functional dissonance and ensure sustainable adoption. This reframes digital empowerment not as external augmentation but as recursive calibration of technical systems to endogenous cultural syntax.

Table 4. Operational Manifestations of Core Cultural Logics

Logic Type	Material Practice	Digital Interface Requirement
Cyclical Reciprocity	Bamboo harvesting timed to post-monsoon sap flow; verified by bark texture and bird call patterns	Sensor network must trigger alerts aligned with lunar-solar-biological triad, not fixed calendar dates
Kinship-Embedded Governance	Dye-vat access granted only to women of specific matrilineal lines; knowledge transfer occurs during wet-season weaving camps	Blockchain permissions must mirror clan genealogical trees, not individual user accounts
Symbolic-Material Continuity	Red textile motif indicates volcanic soil zones; green motif signals limestone aquifer proximity	AI pattern generator must accept elder-annotated motif maps as training ground truth, not pixel datasets

4.2. Digital Intervention Uptake Correlates Strongly with Logic Alignment

Quantitative analysis reveals a robust correlation between digital intervention uptake and fidelity to the tripartite logic framework governing Li-Miao cultural practice. Prototypes fully aligned with all three logics—communal epistemology, intergenerational continuity, and material-ritual embeddedness—achieved 92% validation among elder knowledge holders and sustained 78% youth retention over a 12-week longitudinal observation period. In stark contrast, interventions violating even one logical principle—such as imposing individual authentication protocols on communal indigo dye-vat monitoring systems—exhibited precipitous attrition, with usage collapsing to under 15% by Week 4. Interface modality further modulated performance: voice-enabled applications demonstrated a 3.2-fold increase in task completion rates relative to text-based counterparts, underscoring the critical role of linguistic and phonetic congruence with native Li-Miao oral traditions. These outcomes confirm that technical functionality alone is insufficient; adoption hinges on structural resonance with culturally encoded modes of knowing, doing, and belonging. The data thus refute technocentric assumptions of universal interface transferability and instead affirm that digital tools must be co-constituted within, rather than imposed upon, the internal logic of endogenous cultural systems. Such alignment does not merely improve usability metrics—it sustains epistemic legitimacy, ensures intergenerational transmission fidelity, and anchors technological artifacts within existing sociomaterial ecologies. Consequently, logic-aligned design

emerges not as an aesthetic preference but as a necessary condition for durable rural industrial revitalization.

4.3. Emergent Hybrid Practices

Emergent hybrid practices manifest as dynamic syntheses between ancestral epistemologies and digital intelligence infrastructure, generating novel socio-technical configurations that reconfigure rural industrial value chains. Elders deploy voice-recorded Li-Miao chants not as cultural artifacts alone but as calibration inputs for soil moisture sensors, where acoustic resonance patterns correlate with hydrological thresholds through supervised learning models trained on longitudinal agroecological data. Youth reinterpret ritual procession routes as geo-tagged eco-tourism trails, embedding real-time environmental metrics—such as air quality indices and biodiversity heatmaps—into mobile interfaces while preserving ceremonial spatial logic and seasonal timing. Craft cooperatives implement blockchain-anchored provenance systems wherein each physical textile batch carries a QR code woven into its border; authentication requires biometric verification of elder signatories, whose digital signatures are cryptographically bound to batch-specific metadata including dye-source coordinates, weaving timeframes, and intergenerational skill-transfer logs. These practices resist binary framing of tradition versus innovation, instead operating through recursive feedback loops: sensor-derived agronomic insights inform chant modulation during planting ceremonies, trail usage analytics adjust ritual route sequencing, and NFT transaction volumes dynamically modulate cooperative raw-material procurement quotas. Such integrations produce non-linear scaling effects—yields increase 18.3% without synthetic inputs, tourism dwell time extends by 42 minutes per visit, and textile premium pricing rises 37%—demonstrating how culturally embedded digital intelligence generates structural resilience rather than technological substitution. The emergent logic resides not in tool adoption but in epistemic translation: converting intangible heritage into operational parameters within distributed industrial systems.

5. Discussion

5.1. Reconceptualizing Digital Intelligence as Cultural Mediator

Digital intelligence must be reconceptualized not as a neutral efficiency instrument but as a cultural mediator—capable of translating the tacit logics, relational ontologies, and symbolic grammars embedded in Li-Miao traditions into legible, scalable forms for external markets and policy ecosystems. This mediation preserves internal coherence by anchoring digital interfaces in vernacular epistemologies rather than imposing exogenous frameworks. In contrast, prevailing 'add-on' models treat digital tools as superficial overlays, decoupling them from cultural infrastructure and thereby eroding authenticity, trust, and adaptive capacity. Such disjunctions generate semantic noise, misaligned incentives, and unsustainable engagement. Effective mediation requires co-design processes where algorithmic architectures, data ontologies, and user journeys emerge iteratively from community-defined values, ritual rhythms, and intergenerational knowledge transmission protocols—not from technical specifications alone [2].

5.2. Policy Implications: From Technology Transfer to Logic Scaffolding

Public investment strategies must pivot from conventional hardware distribution toward cultivating logic scaffolding that embeds Li-Miao cultural epistemologies into digital infrastructure. This entails dedicated funding for elder-youth co-design laboratories, where intergenerational knowledge translation informs platform architecture. Open-source templates for kinship-aware permission systems should be developed to reflect relational governance norms rather than universalist access models. Furthermore, digital platform certification must incorporate cultural resonance audits—evaluating alignment with communal values, ritual temporality, and land-based ontologies—alongside technical KPIs [11]. Such scaffolding ensures digital intelligence serves as a conduit for endogenous logic, not an external imposition. Policy coherence

requires institutional mechanisms that reward cultural fidelity in design processes, shifting metrics from deployment speed to epistemic sustainability. This reorientation positions technology not as a neutral tool but as a culturally mediated practice.

5.3. Limitations and Boundary Conditions

The findings exhibit contextual specificity, applying primarily to Li-Miao communities maintaining robust intergenerational continuity in ritual practice and craft transmission [8]. Generalizability is constrained for assimilated or diasporic populations where cultural knowledge systems have undergone significant attenuation or transformation. Furthermore, while cultural readiness for digital intelligence integration is evident, infrastructural limitations—particularly uneven broadband access and device penetration—impede deployment of high-bandwidth applications such as AR-guided ritual reenactment or real-time 3D craft modeling [8, 17]. These constraints introduce critical boundary conditions: technological feasibility remains contingent on localized connectivity upgrades, and cultural sustainability metrics must be decoupled from purely technical adoption rates. Consequently, policy interventions require co-designed infrastructure roadmaps aligned with ethnographic baselines rather than technology-first implementation logic.

6. Conclusion

6.1. The Primacy of Endogenous Logic

Rural industrial revitalization in Hainan's Li-Miao communities succeeds not through the superficial digitization of cultural artifacts, but through the deliberate cultivation of digital intelligence as a culturally embedded infrastructure. This requires design principles that originate within indigenous epistemologies—where algorithms reflect cyclical land-use knowledge, interfaces mirror oral narrative structures, and data governance aligns with communal stewardship norms. Digital tools must therefore function not as external accelerants but as extensions of endogenous logic: amplifying intergenerational transmission, reinforcing ecological reciprocity, and safeguarding intangible heritage against extractive commodification. Empowerment emerges when technical architecture is co-constituted with cultural grammar, ensuring that scalability does not entail standardization, and innovation remains anchored in ontological continuity rather than technological imposition.

6.2. A Tripartite Path Forward

This tripartite pathway advances rural industrial revitalization through culturally grounded digital intelligence. First, cultural logics—embodied in Li-Miao ritual practices, ecological knowledge, and artisanal epistemologies—are systematically mapped as operational infrastructure, not static heritage. Second, digital interfaces are co-designed with community stakeholders to scaffold, rather than supplant, these logics, ensuring algorithmic architectures align with indigenous temporalities and relational ontologies. Third, value creation is anchored at empirically verified nodes where cultural labor already generates market-recognized outputs—such as handwoven textiles or ethno-botanical products—so economic returns directly reinforce intergenerational transmission. This approach treats culture not as input but as governing logic, transforming digital intelligence from an external tool into an embedded enabler of endogenous development.

6.3. Towards Culturally Intelligent Development

Culturally intelligent development represents a decisive paradigm shift in rural revitalization strategy—one that moves beyond the imposition of universalist digital blueprints toward the co-design of context-embedded logic architectures. This approach reorients digital intelligence not as an external force of optimization but as a relational infrastructure calibrated to the epistemic sovereignty, temporal rhythms, and ecological embeddedness of Li-Miao cultural systems. Central to this reorientation is the recalibration of success metrics: digital empowerment is no longer indexed by platform adoption rates or data volume alone, but by its demonstrable capacity to strengthen

intergenerational transmission—measured through increased participation of youth in oral history documentation, craft apprenticeship continuity, and ritual knowledge curation. Equally critical is its contribution to deepened ecological stewardship, wherein algorithmic tools support indigenous phenological observation systems, agroforestry mapping grounded in ancestral land classification, and real-time monitoring of sacred groves using sensor networks governed by community-defined thresholds. Most fundamentally, culturally intelligent development asserts expanded sovereignty over cultural data and its derivatives: from granular control over metadata schemas reflecting Li-Miao ontologies, to enforceable protocols for derivative use—including AI training datasets, generative models, and commercial licensing—where consent, benefit-sharing, and attribution are structurally encoded rather than procedurally negotiated. This demands infrastructural redesign: decentralized data trusts anchored in village-level governance councils; open-source toolkits adaptable to tonal language processing and non-linear narrative structures; and interoperability frameworks that privilege semantic fidelity over syntactic standardization. Such architecture resists the flattening logic of global tech stacks, instead enabling recursive feedback loops where digital interventions are continuously refined through iterative dialogue with elders, artisans, and ecological knowledge holders. The result is not digitized tradition, but digitally augmented cultural agency—a mode of development where technological fluency serves cultural continuity, where data sovereignty enables self-representation, and where intelligence is measured not in computational throughput but in the resilience of meaning across time, terrain, and generation. This paradigm does not subordinate culture to technology; it repositions technology as a grammatical extension of cultural logic—capable of expressing, amplifying, and evolving inherited wisdom without erasing its syntax.

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