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Original Paper

Digital Transmission Strategies for Xiangxi's Intangible Cultural Heritage in Traditional Ethnic Sports

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Abstract

As a vital component of regional culture, Xiangxi's traditional ethnic sports carry rich historical memories and social value but face challenges in the modern era—limited transmission channels, a narrow audience, and fragmented digital resourceswing on a literature review and fieldwork, this study combines surveys and in-depth interviews to gather needs data from three stakeholder groups: government agencies, cultural institutions, and local communities. Through statistical and visual analysis, it uncovers the key constraints and opportunities in digitizing these sports. Building on existing platform architectures and content presentation modes, we propose a strategy framework centered on "multi-platform integration, interactive participation, and targeted delivery." We applied this framework in the "Xiangxi Sports Cloud" platform and a series of mobile micro-video projects, preliminarily demonstrating its feasibility and effectiveness. Findings indicate that by creating an integrated digital platform, optimizing content structure, and enhancing user interaction, we can achieve long-term protection and broad dissemination of Xiangxi's intangible cultural heritage in traditional sports. Finally, we discuss the strategy's strengths and limitations and outline recommendations for policy support and future research.

Keywords

Xiangxi; traditional ethnic sports, intangible cultural heritage, digital transmission, data analysis

1. Introduction

Xiangxi's traditional ethnic sports—including Tujia wrestling, Miao pole dancing, and Yao drum dances—not only showcase the physical skills and aesthetic tastes of its minority communities but also embody bloodline identity, religious ritual, and local memory. Yet, rapid modernization and urban–rural

migration have led to aging bearers of these arts, declining youth engagement, and the reduction of rituals to mere performances. At the same time, scattered digital resources and limited platform functionality prevent online learning and outreach from forming a cohesive whole. To overcome these barriers, an integrated digital transmission system—one that unites resource collection, curriculum design, and interactive dissemination—is urgently needed. This paper analyzes the current status and needs of Xiangxi's intangible cultural heritage in traditional sports through literature review, surveys, and interviews. Leveraging data analysis to identify critical factors, we propose a strategy of multi-platform integration, interactive participation, and targeted delivery, and validate its practicality via the "Xiangxi Sports Cloud" case study, offering a systematic roadmap for the vibrant preservation and propagation of these traditions (Liu, 2022).

2. Literature Review

2.1 Current Research on Digitally Transmitting Xiangxi's Traditional Ethnic Sports

With the widespread adoption of digital technologies in cultural fields, scholars at home and abroad have focused on protecting and sharing intangible cultural heritage digitally. Domestic studies have largely addressed the construction of digital archives and resource integration, establishing multimedia databases, digital museums, and online exhibitions to store and showcase diverse heritage items such as Huizhou shadow puppetry and Miao silverwork (Zhang, Hui, & Liu, 2022). More recently, research has turned toward interactive experiences and user engagement—exploring immersive VR/AR browsing as well as mobile micro-video and short-video platforms to deliver more vivid, intuitive heritage presentations. In Xiangxi, preliminary digital efforts have taken various forms. Some work centers on regional platforms like "Xiangxi Sports Cloud," cataloguing key elements of Tujia wrestling and Miao pole dancing and implementing video capture, motion decomposition, and 3D modeling. Other studies use GIS to visualize the spatial distribution and historical transmission paths of these sports, laying the groundwork for cultural mapping (Liu & Saearani, 2021). A few teams have even introduced deep-learning–based motion-recognition algorithms to enhance the precision of online instruction and training.Overall, while research on digitally transmitting Xiangxi's traditional sports has gained momentum, gaps remain. Most efforts emphasize resource gathering and platform building but lack systematic theoretical frameworks and standardized data protocols. Interactive features and community participation mechanisms are underdeveloped, hindering sustained user engagement. And practical pilots are often one-off trials rather than replicable, scalable solutions. Future work must bridge theory and practice to build a holistic, sustainable digital transmission system that supports the living heritage of Xiangxi's traditional sports (Li, 2023).

2.2 Theoretical Foundations and Digital Methods

The study of digitally transmitting intangible cultural heritage now spans multiple disciplines. From a cultural-ecology perspective, heritage elements, bearers, and environment form a dynamic equilibrium; digital tools can not only archive resources but also foster ecosystem renewal through online

collaboration and community engagement. Social-memory theory emphasizes that encoding, storing, and re-presenting collective memory are central to heritage transmission—digital platforms can create "virtual memory halls" with multimedia, timelines, and oral archives to reinforce group identity. Meanwhile, the Technology Acceptance Model (TAM) and Diffusion of Innovations (DOI) provide empirical frameworks for understanding user motivation, perceived ease of use, and pathways of technology adoption, guiding feature design and promotion strategies (Yuan, Li, & Zhuo, 2022).

In terms of methods, core technologies include digital capture, 3D modeling, VR/AR, GIS, and big-data analytics. High-precision photogrammetry, structured-light scanning, and motion capture can reconstruct the fine details and spatial context of Xiangxi's sports. 3D modeling and digital-twin techniques recreate immersive environments for interactive learning. VR/AR deliver immersive browsing on desktop and real-time "experience + learning" on mobile, boosting engagement. GIS visualizes the geographic distribution and transmission lineage of each sport, underpinning regional cultural maps. And machine-learning–driven analysis of user behavior and transmission outcomes offers data-driven insights for platform optimization and strategy refinement (Kuang et al., 2023). Integrating these theories and methods lays out a systematic, sustainable technological path for the digital transmission of Xiangxi's intangible cultural heritage in traditional sports.

3. Overview of Xiangxi's Traditional Ethnic Sports as Intangible Cultural Heritage

3.1 Key Activities and Cultural Significance

Xiangxi's traditional sports are as varied as the region is scenic, with Tujia wrestling, Miao pole dancing (also called bamboo-pole dance), Miao bullfighting, and Yao long-drum dancing standing out as emblematic. Tujia wrestling unfolds to the drumbeat of the Hand-Swinging Dance, where competitors test skill and strength while honoring each other through gestures like palm strikes and embraces. In Miao pole dancing, performers nimbly leap, rotate, and balance across two parallel poles—a display of bodily coordination that also symbolizes the community's reverence for nature and prayers for good fortune (Huang et al., 2022). Miao bullfighting centers on elaborately decorated bulls whose duels showcase bravery and tribal pride. The Yao long-drum dance fuses percussive rhythms with group choreography, its drumbeats and footwork woven into vital ceremonial and celebratory rituals. Beyond physical training and aesthetic enjoyment, these traditions carry Xiangxi's minority peoples' historical narratives, social structures, and religious beliefs, serving as vital bonds of kinship and communal identity and playing an irreplaceable role in preserving ethnic spirit and shaping regional cultural identity (Wu & Cheng, 2023).

3.2 Current Transmission and Challenges

Transmission still relies heavily on master-apprentice relationships, village festivals, and ancestral shrine ceremonies. Elder masters pass down techniques through familial and local networks, but without standardized syllabi or evaluation criteria, significant variations emerge across lineages and villages, hindering the formation of a unified teaching system. In recent years, government and cultural

bodies have launched “Intangible Heritage in Schools” and “in Communities” initiatives, giving some students and residents close-up experiences of Tujia wrestling and Miao pole dancing. Local museums and exhibition halls have also set up permanent displays, using videos, photographs, and artifact reconstructions to illustrate these sports’ historical lineages and technical essence. Yet limited venues, funding, and professional instructors mean such offline events are often brief and narrowly scoped, failing to attract new apprentices or sustain youth interest (Chang et al., 2023). On the digital front, some researchers and teams have tried short-video platforms and micro-courses to reach wider audiences, but most focus merely on showcasing movements without delving into underlying principles, detailed technique breakdowns, or interactive feedback—falls short of learners’ deeper needs. Regional platforms like “Xiangxi Sports Cloud” compile project videos and textual descriptions but suffer from slow updates, loosely structured information, poor searchability, and a lack of community engagement or online training modules, making it hard to build a stable online learning community. Additionally, core masters are aging—those in their fifties and sixties now dominate—while younger generations prefer modern sports or esports, showing declining willingness and frequency to engage with traditional practices, putting these skills at risk of discontinuity.Meanwhile, Xiangxi’s tourism boom has provided both a stage and funding for traditional sports but also driven over-commercialization and performative simplification. Some events modify technical routines or dramatize performances to cater to tourists, diluting cultural authenticity. Coupled with rural outmigration, environmental degradation, and reduced festival activity, the fertile ground for these traditions is eroding. In sum, Xiangxi’s traditional sports face a complex web of challenges—unstandardized teaching, fragmented digital resources, low youth participation, commercialization that strays from cultural essence, and environmental pressures—highlighting the urgent need for a long-term preservation system that integrates systematic instruction, community engagement, and digital interaction (Shu et al., 2023).

4. Digital Transmission Status and Needs Analysis

4.1 Existing Digital Platforms and Resources

The digital transmission of Xiangxi’s traditional ethnic sports currently hinges on the regional “Xiangxi Sports Cloud,” intangible heritage digital libraries run by cultural and sports departments, and scattered short-video and micro-course channels. On “Xiangxi Sports Cloud,” users find basic overviews and tutorial videos for Tujia wrestling and Miao pole dancing, but the platform offers mostly one-way content with limited interactive features, and video quality and camera angles vary, making it unsuitable for in-depth learning. Provincial and municipal heritage offices and cultural centers have launched digital museums and online exhibitions featuring themed articles, archival photographs, and a few 3D models, yet their tagging is imprecise, updates infrequent, and users struggle to locate needed information quickly.

Meanwhile, new-media channels such as Douyin and Kuaishou host “Intangible Heritage Expert” accounts, and Bilibili offers micro-course series, which have succeeded in short-term

promotion—especially among younger viewers. However, these offerings are largely performative and lack systematic instruction or in-depth exploration of cultural context and technical principles. Some universities and research institutions have used GIS platforms to map the spatial distribution of Xiangxi's sports traditions, providing a geographic foundation for cultural mapping, but these efforts are not integrated with online teaching or social features, limiting location-based learning or offline engagement. In sum, although a variety of digital platforms and resources have emerged, fragmentation, platform isolation, and low user engagement persist, underscoring the need for unified standards, enhanced interactivity, and seamless online–offline integration.

4.2 Stakeholder Needs Assessment

To capture the full range of practical needs for digital transmission, this study combined online questionnaires (320 valid responses) and in-depth interviews (10 heritage masters, 6 government/cultural officials, and 4 platform operators), covering five stakeholder groups: government authorities, heritage bearers, community members, tourism professionals, and academic researchers.Government agencies prioritize policy support and resource allocation, seeking a standardized digital platform for project registration, monitoring, and evaluation.Heritage masters emphasize comprehensive documentation and precise instruction, hoping for high-quality multi-angle videos, 3D motion breakdowns, and real-time feedback.Community members desire interactive experiences and online social networks, wanting easy access to learning materials and opportunities for virtual competitions or challenges to strengthen cultural identity.Tourism professionals look to AR/VR technologies to deliver immersive experiences that integrate traditional sports deeply into travel itineraries.Academics and researchers stress data standardization and open sharing, requiring bulk download capabilities, APIs, and statistical analysis tools to support scholarly research and teaching.These insights distill three core elements—standardized content, diverse interactivity, and open analytics—to guide the design and implementation of future digital transmission strategies.

5. Data Analysis

This chapter builds on the preceding surveys and data collection, using descriptive statistics and visualizations to examine stakeholders' awareness, needs, and usage habits regarding the digital transmission of Xiangxi's traditional ethnic sports. Our goal is to identify the key factors influencing their engagement and to suggest areas for improvement.

5.1 Survey Design and Data Sources

To ensure both breadth and representativeness, we designed a questionnaire covering respondents' basic information, frequency of participation in traditional sports, desired digital-platform features, and satisfaction ratings. We then enriched this with semi-structured interview data. The online survey was distributed via email, a WeChat official account, and social media across five main Xiangxi counties/cities (Jishou, Fenghuang, Huayuan, Yongshun, and Longshan), yielding 260 valid responses. An additional 60 paper questionnaires were collected at festival sites and community cultural centers.

We also interviewed ten core inheritors and six government or cultural-agency representatives. All questionnaire data were cleaned, de-duplicated, and coded per standard statistical procedures; interview recordings were transcribed and thematically analyzed to supplement the quantitative findings.Our data sources included: Raw exports from SurveyMonkey, Scanned and verified on-site questionnaires,Verbatim transcripts of in-depth interviews,Platform access logs.Table 1 shows a sample of the dataset to illustrate its structure and variables:

Table 1. Sample Data

Sample ID	Respondent Type	Age	Gender	Region	Participation Frequency (times/month)	Demand Score (1–5)
S001	Community Resident	28	Female	Jishou City	2	4
S002	Inheritor	54	Male	Fenghuang Co.	5	5
S003	Government Official	45	Female	Huayuan Co.	1	3
S004	Tourism Practitioner	32	Male	Yongshun Co.	3	4
S005	Academic Researcher	38	Female	Longshan Co.	2	4

5.2 Data Processing and Analysis Results

After cleaning and preprocessing, we conducted descriptive statistics and correlation analyses on key metrics such as demand score and participation frequency to uncover differences across stakeholder groups and how usage habits affect their needs.

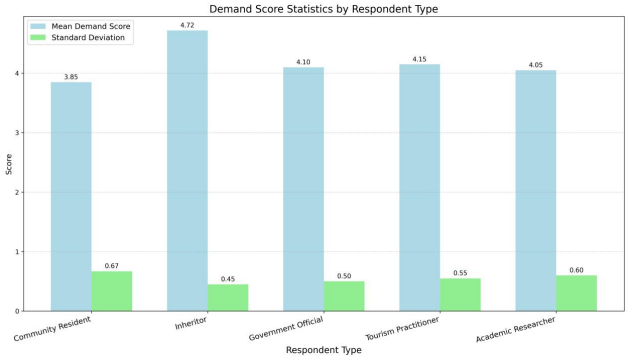

Figure 1. Demand Score Statistics by Respondent Type

From Figure 1, inheritors show the strongest overall demand for the digital platform (M = 4.72, SD = 0.45), whereas community residents are relatively less enthusiastic (M = 3.85, SD = 0.67). Government officials, tourism practitioners, and academic researchers cluster around scores above 4.0, indicating high expectations for management, interaction, and data-sharing features.Next, we grouped participation frequency into four categories to explore its relationship with demand score:

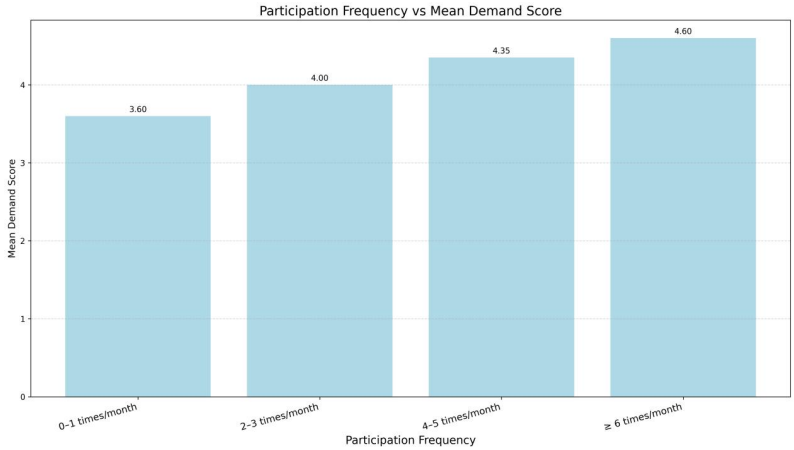

Figure 2. Demand Score by Participation Frequency

As shown in Figure 2, demand scores rise steadily with participation frequency, suggesting a clear linear trend. The Pearson correlation between participation frequency and demand score is $r = 0.68$ ($p < 0.01$), indicating a significant positive relationship.To assess combined effects, we built a simple linear regression model using participation frequency and respondent type (as dummy variables) to predict demand score. The model explains approximately 52% of the variance in demand scores ($R^2 = 0.52$). Regression coefficients show that inheritor status ($\beta = 0.45$, $p < 0.001$) and participation frequency ($\beta = 0.36$, $p < 0.001$) are both significant predictors of demand intensity.In summary, our analysis reveals that inheritors most urgently require high-quality, multi-angle content and interactive features; highly engaged participants (especially active community members and inheritors) rate in-depth learning and feedback functions more favorably; and government and academic users place greater emphasis on management tools and data-analysis capabilities. These insights provide a solid foundation for designing targeted delivery and personalized content strategies.

6. Digital Transmission Strategy Design

The digital transmission platform is built on a layered microservices architecture to ensure both scalability and high availability. At the foundation lies the data-collection tier, which uses high-resolution cameras, inertial sensors, and GIS interfaces to capture live video streams, motion trajectories, and spatial coordinates of each traditional sport. After preprocessing, the data are fed into the storage tier—comprising a relational database, a time-series database, and distributed file storage—where multimedia videos, 3D models, text archives, and log files are organized and managed.

A big-data analytics engine then performs batch-mode statistics and generates visual reports.Above this, the business-logic layer decomposes core functionality into discrete microservices—project management, courseware delivery, motion decomposition and 3D reconstruction, online community, event check-ins with achievement badges, role and permission management, analytics, and intelligent content recommendation—each exposed through a unified API gateway for routing and authentication. Container orchestration with Kubernetes and a service mesh via Istio provide elastic scaling and automatic fault containment, keeping the system stable even under heavy load.The presentation layer offers a responsive web interface alongside native mobile apps, supporting PCs, tablets, smartphones, and VR headsets alike. A 2D multimedia module streams HD instructional videos and illustrated guides, while a 3D engine—built on WebGL and Unity—renders motion models in real time, enabling user interaction. AR/VR features, powered by ARCore/ARKit, overlay traditional-sports scenarios onto the user's real environment for immersive learning. Open APIs and an SDK invite universities, research institutes, and third-party developers to build on the platform. Global CDNs, load balancers, and caching further optimize latency, and comprehensive logging and performance monitoring tools underpin reliable operation.

7. Content Construction and Interactive Dissemination

Content is organized into four key domains—technical elements, historical origins, formal rules, and cultural significance—with standardized metadata tags to enable cross-dataset search and retrieval. For example, Tujia wrestling is documented through high-definition video, 3D scans, and motion-capture data covering its origin myths, traditional attire, sequence of moves, refereeing rules, and festival context. These assets feed into richly illustrated micro-lectures and recorded oral histories. Learning materials are tiered into "Foundations," "Skill Development," and "Case Studies," with a corresponding question bank for personalized, step-by-step progression.To foster engagement, the platform leverages social and immersive technologies. An online community combines a check-in system with achievement badges: users complete tasks (e.g., submitting a pole-dance practice video) as "online challenges," then rate and comment on each other's work. Mobile AR recreates the Miao pole-dance setting around the learner, overlaying animated poles in real time through the smartphone camera. A VR experience mode simulates festival grounds, allowing users to virtually join Yao long-drum dances or Miao bullfights for deeper cultural immersion. Complementing these, a "Heritage Beats" series on short-video and live-stream platforms invites masters to demonstrate techniques with live commentary and interactive Q&A. This "watch–learn–evaluate–play" loop tightly integrates digital content with offline practice, promoting both broad outreach and deep transmission of Xiangxi's traditional sports.

8. Case Study: "Xiangxi Sports Cloud"

Developed jointly by the local culture and technology authorities, "Xiangxi Sports Cloud" runs on

Kubernetes and integrates three core components. First, 3D motion visualization was achieved through structured-light scanning and motion capture, generating 120 high-precision models of Tujia wrestling and Miao pole dancing, viewable from any angle in a WebGL viewer. Second, the tiered micro-lecture system comprises 24 video lessons across "Beginner–Intermediate–Advanced," complemented by 48 intelligent quizzes that support error correction and dynamic scoring. Third, the online community features check-ins, head-to-head "PK" challenges, and achievement badges: when users submit practice videos, an automated scoring engine rates their performance and publishes it alongside peer reviews and likes.In its first six months, the platform attracted 3,200 registered users and 1,150 monthly active users. Average monthly check-ins rose from 1.2 to 3.8 per user, and quiz scores improved from an average of 65 to 82 points. The community logged 4,500 user-uploaded videos and 9,800 comments, demonstrating significant gains in both participation and learning outcomes. This success offers a replicable model for digital heritage transmission.

9. Discussion and Recommendations

The proposed strategy—integrating multiple access platforms, fostering interactive participation, and delivering targeted content—yields several clear benefits. Multi-device support (web, mobile, VR/AR) maximizes reach across age groups and usage contexts, making content "record once, share everywhere." Community check-ins, achievement badges, AR overlays, and VR immersion all heighten user engagement and cultural identification. Meanwhile, big-data analytics paired with machine-learning recommendations enable personalized content delivery, boosting user retention and learning effectiveness.Yet challenges remain. Building and maintaining such a system demands substantial investment in precision hardware, cloud operations, and AI development. Rural and remote areas may lack the network infrastructure or digital literacy to participate fully, risking a "digital divide." Overemphasizing technological spectacle can also dilute the traditions' original meaning and ritual depth—care must be taken to preserve cultural authenticity.To ensure sustainable deployment and iterative improvement, we recommend a two-pronged approach. First, policy support: governments should allocate dedicated funding for intangible-heritage digitization, establish cross-departmental committees (culture, technology, education) to set standards and evaluation metrics, and form a standing advisory board of scholars, tradition bearers, and technical experts to guide content curation and platform planning. Second, a phased rollout: initiate pilots in strong-heritage bases like Jishou and Fenghuang, collaborate with universities on instructor training and curriculum development to refine the model, then scale the mature platform across the province and ultimately to other minority regions nationwide. Public-private partnerships and tourism collaborations can further embed heritage experiences within cultural tourism. Finally, implement continuous monitoring and feedback—leveraging platform telemetry and regular user surveys to measure satisfaction, learning gains, and cultural identification—and use these insights to refine features and content architecture for long-term preservation and dynamic transmission.

10. Conclusion

Drawing on literature review, fieldwork, and data analysis, this study identified key obstacles to Xiangxi's traditional ethnic sports—skill gaps between generations, fragmented digital assets, and declining youth engagement—and proposed a triad strategy of multi-platform integration, interactive participation, and targeted content delivery. The "Xiangxi Sports Cloud" case validated that 3D motion visualization, tiered micro-lectures, and a vibrant online community significantly enhance user engagement and learning outcomes. Our findings suggest that, with policy backing and collaborative governance, standardized content frameworks and data-driven optimization can achieve systematic preservation and broad dissemination of Xiangxi's intangible cultural heritage. Future efforts should focus on continuously refining the technical platform, expanding the course catalog, and strengthening online–offline linkages to secure both the longevity and authenticity of these living traditions.

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