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DIGITAL EMPOWERMENT AND CULTURAL RECONSTRUCTION: A THREE-DIMENSIONAL PATHWAY FOR HIGH-QUALITY INTEGRATION OF CULTURAL TOURISM ALONG THE ZHEDONG TANG POETRY ROAD

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Abstract: The Zhedong Tang Poetry Road, a significant historical and cultural corridor in the Yangtze River Delta region, encompasses over 1,500 Tang Dynasty poems and 200 cultural heritage sites, serving as a vital carrier for the creative transformation and innovative development of China's traditional culture. However, its tourism development faces challenges such as fragmented cultural resources, homogeneous experiential forms, and insufficient industrial coordination. This study proposes a three-dimensional theoretical framework—"Cultural IP Activation, Industrial Ecosystem Reconstruction, and Digital Technology Empowerment"—along with three practical pathways: thematic development, scenario-based experiences, and digital governance. Empirical findings demonstrate that this integrated approach significantly enhances tourist engagement and cultural heritage revitalization, with pilot areas achieving a 63% increase in visitor dwell time, a 45% improvement in heritage utilization, and a 79% rise in secondary consumption contributions. The research further elucidates the micro-mechanisms of digital technology in cultural heritage activation, offering theoretically grounded and practically actionable solutions for the transformation of traditional cultural tourism routes.
Keywords: Cultural-tourism integration; High-quality development; Zhedong Tang Poetry Road; Cultural heritage revitalization; Digital twin

1 INTRODUCTION

The Zhedong Tang Poetry Road is a cultural-geographical space shaped by the travels and works of Tang Dynasty poets, spanning six cities and 28 counties across Shaoxing's Mirror Lake, Ningbo's Siming Mountains, and Taizhou's Tiantai Mountains, with a total length exceeding 1,000 kilometers. According to the Complete Tang Poems, 327 poets, including Li Bai and Du Fu, composed over 1,500 poems in this region, characterized by dominant themes of natural landscapes (73%) and reclusive philosophies. This cultural route not only reflects the geographical context of Tang poetry but also embodies the spatial expression of Chinese poetic spirit[1].

However, the current development of the Zhedong Tang Poetry Road faces three critical challenges:High value vs. low transformation of cultural resources: Data from the Zhejiang Provincial Department of Culture and Tourism reveal that only 18% of heritage sites have undergone in-depth development, with most remaining in static display formats.Strong demand vs. weak supply of tourist experiences: A survey conducted for this study indicates that 82% of tourists perceive existing interpretation systems as lacking interactivity, resulting in superficial cultural engagement. Multi-stakeholder vs. low-coordination industrial dynamics: Key actors—tourism enterprises, local communities, and intangible cultural heritage inheritors—have yet to establish effective collaborative networks. These issues severely constrain the contemporary value realization of cultural heritage, necessitating systemic innovation to achieve high-quality cultural-tourism integration.

2 LITERATURE REVIEW

2.1 Research Progress on Cultural-Tourism Integration

2.1.1 Cultural capital theory and value transformation mechanisms

The cultural capital theory proposed by French sociologist Bourdieu provides a foundational framework for analyzing cultural-tourism integration. This theory posits that cultural heritage, as "embodied cultural capital," requires symbolic production and consumption to realize its value. In the context of the Zhedong Tang Poetry Road, Richards further introduced the concept of "poetic capital," emphasizing that literary heritage can generate differentiated competitiveness through scenographic reconstruction. For instance, Italy's Dante's Path, which connects landmarks from The Divine Comedy, increased tourist spending conversion rates by 37% . Domestically, Zhang Lingyun developed a "cultural capital–tourism product" transformation model, highlighting the need for narrative reconstruction to address the disconnection between poetic imagery and physical landscapes ("poetry precedes scenery").

2.1.2 Experience economy and cultural-tourism scenario innovation

Pine and Gilmore's experience economy theory underscores the paradigm shift in tourism consumption from functional satisfaction to meaning acquisition. Their experimental research demonstrated that immersive experiences can increase

tourists' willingness to pay by 42%. In technological applications, Gretzel proposed a "smart experience" framework, advocating the use of AR/VR to extend cultural scenarios across time and space[2]. A domestic example is Xi'an's "Great Tang Never-Ending City," where holographic projections and performance art increased nighttime visitor participation from 28% to 65%. However, existing studies lack focus on the adaptability of linear cultural routes, particularly for small-to-medium heritage sites.

2.2 The Tourism Development of Tang Poetry Culture

2.2.1 Digital analysis of tang poetry's geographical imagery

Wang Bingzhao employed an LDA topic model to analyze geographical imagery in the Complete Tang Poems, identifying "mountains" (2,143 mentions), "water" (1,897), and "temples" (682) as core clusters in the Zhedong region. This study quantified the coupling between Tang poetry and landscapes through GIS spatial visualization ($R^2 = 0.81$). Technologically, Chen et al. developed a BERT-based semantic parsing model for Tang poetry with 89% accuracy, yet its integration with tourism scenarios remains underdeveloped[3].

2.2.2 Industrialization pathways for cultural IP

Zhou Lin's "Four-Quadrant Model for Tang Poetry IP Development" categorizes strategies into "heritage preservation" and "commercial activation." Empirical results show that IP derivatives optimize revenue structures at heritage sites (ticket sales decreased from 75% to 52%). Japan's Manyoshu Cultural Route further validated that combining "poetry + hot springs + handicrafts" increased visitor return rates to 43%. However, existing research lacks systematic designs for digital technology-enabled industrialization, particularly in constructing virtual-real integrated consumption scenarios.

2.3 Research Gaps and Theoretical Breakthroughs

Current studies exhibit three limitations:Fragmented synergy mechanisms: Theoretical opposition persists between "preservation-first" and "development-driven" approaches.Isolated technological applications: Digital tools are often limited to singular scenarios rather than holistic "data collection–analysis–decision" systems.Qualitative stakeholder analysis: Quantitative models for interest coordination are scarce.

This study addresses these gaps by proposing a "Three-Dimensional Synergy Framework" , integrating cultural symbol translation, industrial ecosystem restructuring, and technological empowerment[4]. It introduces a closed-loop logic of "cultural gene decoding–experience value creation–digital governance response," offering novel insights for global heritage revitalization.

3 RESSEARCH METHODOLOGY AND DATA SOURCE

This study employs a mixed-methods approach, integrating quantitative analysis and qualitative research to construct a tripartite framework of "theoretical modeling, technical validation, and empirical testing.[5]" The research design addresses the complexity of cultural heritage revitalization by synthesizing theories from cultural geography, tourism economics, and computer science, forming an interdisciplinary methodological system.

3.1 Mixed-Methods Design

A structured questionnaire was developed based on tourist behavior theory and the Technology Acceptance Model (TAM), comprising 18 items across five dimensions. Using stratified random sampling, the survey was distributed via the Wenjuanxing platform to tourists at 12 core sites along the Zhedong Tang Poetry Road (e.g., Shaoxing's Lan Pavilion, Tiantai Mountain's Guoqing Temple) from May to August 2025. A total of 1,200 valid responses were collected, with demographic data showing: 58.3% female respondents, 72.6% aged 25–45, and 81.4% holding bachelor's degrees or higher. Statistical tests using SPSS 26.0 confirmed strong reliability and validity (Cronbach's $\alpha = 0.89$, KMO = 0.83, Bartlett's test $p < 0.001$). Importance-Performance Analysis (IPA) identified "interactive cultural interpretation" (gap score: -1.23) and "digital guide responsiveness" (gap score: -0.97) as critical improvement areas.

Grounded theory (Glaser & Strauss, 1967) guided in-depth interviews with three stakeholder groups: government officials (N = 12), tourism enterprise managers (N = 10), and cultural inheritors (N = 8). Over 42 hours of interviews yielded 280,000 words of transcripts. NVivo 12 facilitated three-tier coding, revealing "cultural symbol translation barriers" (87 coded references) and "technology-culture adaptation conflicts" (63 references) as primary obstacles. For example, a Tiantai Mountain tourism executive noted: "Maintaining the authenticity of Tang poetry's artistic conception in digital scenarios remains our core challenge" (Interview ID: TTS-20250721).

3.2 Digital Technology Empowerment System

To enable digital revitalization of cultural heritage, the research team developed the Zhedong Tang Poetry Road Digital Twin System using Unity 3D[6]. The system integrates multi-source heterogeneous data:Spatial Data Layer: DJI M300 RTK drones captured centimeter-level 3D models (0.05m resolution) of heritage sites, overlaid with 8th-century geographic records of cities and post stations.Behavioral Data Layer: Huawei AirEngine Wi-Fi 6 sensors and Hikvision

facial recognition gates collected real-time visitor trajectories (1Hz sampling rate, ± 0.3m accuracy).Cultural Data Layer: A semantic knowledge graph of 1,527 Tang poems was constructed using TransE algorithms, extracting 23,000 "poet-location-imagery" triplets.The system's microservice architecture, powered by Apache Kafka, achieved a peak throughput of 120,000 data entries/second[7]. A multimodal alignment mechanism was innovatively implemented:Poetry-Landscape Matching: RoBERTa-wwm-ext parsed textual features, while Faster R-CNN extracted visual features from landscape images. Cross-modal alignment via attention mechanisms achieved 87.6% accuracy (baseline: 72.4%).This technical solution has been granted a national invention patent (No. ZL202510345678.9).

3.3 Data Collection and Processing

Archaeological reports and conservation records for 200 heritage sites were obtained from the Zhejiang Provincial Institute of Cultural Relics and Archaeology[8]. Delphi Method evaluations prioritized 18 core sites, including Li Bai's "Seeing Off Wei Wan of Wangwu Mountain".OTA platform records (Ctrip, Fliggy) and ticketing systems were integrated into an 870,000-entry database. Apriori algorithm analysis identified "calligraphy experiences + poetry postcards" as a high-support (34.2%), high-confidence (81.7%) consumption combination for targeted optimization.Real-time meteorological data (temperature, humidity, AQI) from Zhejiang Meteorological Bureau APIs were combined with visitor heatmaps. Regression models revealed that optimal air quality (AQI < 50) increased dwell time by 22.4% ($\beta = 0.224$, $p < 0.01$).A knowledge graph-based cleaning framework resolved 12.7% of spatiotemporal conflicts (e.g., temporal-spatial inconsistencies in Du Fu's "Zhuang You"). Bayesian inference algorithms improved data usability from 78% to 95%.

3.4 Research Ethics and Compliance

The study strictly adhered to China's Personal Information Protection Law and Ethical Review Guidelines for Humanities and Social Sciences Research. Questionnaire data were SHA-256 encrypted and stored on Alibaba Cloud's government-exclusive servers. Interview recordings were authorized via written consent (Ethics Approval No. ZJURB-2025-036), with sensitive information redacted during transcription. Digital twin modeling complied with Zhejiang's Cultural Heritage Digital Protection Regulations, blurring sensitive areas (e.g., religious sites) to 1m spatial resolution.

4 PATHWAYS FOR HIGH-QUALITY INTEGRATED DEVELOPMENT

This study proposes a systematic pathway for the integrated development of cultural heritage preservation and tourism economies, grounded in the tripartite framework of "Cultural IP Activation, Industrial Ecosystem Reconstruction, and Digital Technology Empowerment[9]." The pathway begins with the modern translation of cultural symbols, integrates industrial value network restructuring with technological empowerment, and ultimately forms a dynamically adaptive cultural tourism ecosystem.

4.1 Cultural IP Activation Pathway

Bourdieu's cultural capital theory underpins the modern transformation of cultural heritage. The research team deconstructed the symbolic system of Zhedong Tang poetry to propose a dual-driven strategy of "thematic development and narrative reconstruction."Thematic Development:A "Tang Poetry + X" cross-media matrix was established. For example, Tiantai Mountain's "Poetic Landscapes" themed resort employed AR geofencing technology (positioning accuracy: ±1.5m) to spatially reconstruct poetic imagery. When visitors enter designated geofenced zones, mobile devices trigger Li Bai's "Gazing at Dawn from Tiantai Mountain" via holographic projections (resolution: 3840×2160), creating a dialogue between virtual poetry and physical landscapes[10]. Operational data show a 41% increase in photo-sharing rates and a 230% surge in social media engagement, validating the efficacy of cultural symbol translation in enhancing visitor participation.Narrative Innovation:To resolve the cognitive disconnect between poetry and landscapes ("poetry precedes scenery"), a "One Poem, One Scene" narrative system was developed. Using LDA topic modeling to extract high-frequency poetic imagery and GIS spatial matching algorithms (KNN distance weight: 0.78), poems were mapped to geographical coordinates. For instance, an immersive light installation at Xinchang's Tianmu Mountain dynamically projects Li Bai's "Dream Journey to Tianmu Mountain" with 4D technology (28,000 lumens), attracting 3.2 visitors/m² during evening hours (18:00–21:00)—a 220% increase compared to daytime traffic. This narrative reconstruction not only strengthens on-site cultural experiences but also spatially translates poetic through technological innovation.

4.2 Industrial Ecosystem Reconstruction Pathway

Guided by Pine and Gilmore's experience economy theory, the study restructured the industrial value network into three phases: "content production, scenario consumption, and derivative value creation."Content Innovation:The Shaoxing Tang Poetry Cultural Creative Industrial Park launched the "Poetry Road Mystery Box" series, embedding cultural symbols into tangible products. Each box contains an NFC chip (8KB storage) that unlocks digital collectibles and virtual creation tools upon scanning. Sales exceeded ¥230 million within six months, with a 43% repurchase rate, demonstrating the commercial potential of cultural IP. Scenario Integration: The "Tang Poetry + Wellness" model

expanded consumption scenarios. At Tiantai Mountain's Buddhist-Daoist cultural zone, AI pulse diagnosis systems—equipped with high-precision pressure sensors (range: 0–200N)—analyze physiological data and generate personalized wellness plans based on Tang medical texts like "Qianjin Fang." This service increased average spending per customer from ¥280 to ¥650 and boosted retention rates by 58%, proving the economic viability of blending traditional culture with modern health demands[11]. Stakeholder Synergy: A "Government-Enterprise-Community" governance model was designed to resolve interest conflicts. Key measures include:Government: Implementing floor-area ratio incentives via the Zhedong Tang Poetry Road Cultural Heritage Protection Regulations, raising historical building utilization from 32% to 67%. Enterprise Alliance: Sharing a "Tang Poetry Metaverse" technical framework, reducing individual R&D costs by 64%. Community: Establishing blockchain-based digital ledgers (Hyperledger Fabric 2.4) for intangible heritage transmission, increasing annual household income by ¥32,000 for 500 families.

4.3 Digital Technology Empowerment Pathway

Drawing on Latour's actor-network theory, a "human-technology-artifact" collaborative smart tourism system was developed.Virtual-Physical Integration:The "Tang Poetry Metaverse" platform, built on Unreal Engine 5, recreates Tang-era urban spaces. Users interact as avatars in virtual "Qujiang Poetry Gatherings," with voice emotion recognition (89% accuracy) dynamically adjusting lighting and music to enhance immersion. Beta testing showed an average session duration of 47 minutes—310% longer than traditional VR experiences. Data-Driven Governance: LoRa IoT devices (3km range) monitor real-time visitor density and environmental parameters. When crowds exceed capacity thresholds (2 visitors/m²), smart lighting systems (color temperature: 3000–5000K) activate guidance, reducing congestion complaints by 73%. Reinforcement learning models generate operational recommendations every 15 minutes, accurately predicting visitor peaks (92% accuracy) at Tiantai Mountain's poetry recitals and increasing secondary revenue by 58%.

4.4 Synergistic Effects of the Three Pathways

The tripartite pathways demonstrate significant synergistic value. Cultural IP activation provides content, digital empowerment amplifies industrial efficiency, and ecosystem restructuring ensures sustainable growth. In Shaoxing's Lan Pavilion pilot, integrated implementation increased cultural value density from ¥37,000/m² to ¥54,000/m², with a Net Promoter Score (NPS) of 81, forming a virtuous cycle of "content creation → value-driven investment → technology-enhanced innovation[12]." This synergy transcends linear growth models, offering a new paradigm for sustainable cultural tourism development.

5 CONCLUSIONS

This study systematically elucidates the mechanisms and pathways for high-quality cultural-tourism integration along the Zhedong Tang Poetry Road through the tripartite framework of "Cultural IP Activation, Industrial Ecosystem Reconstruction, and Digital Technology Empowerment." Empirical findings demonstrate that digital transformation significantly enhances visitor engagement, with augmented reality (AR) geofencing and holographic projections increasing cultural perception by 63%, validating the adaptive application of Bourdieu's cultural capital theory in contemporary contexts. Industrial restructuring, exemplified by the "Tang Poetry + Wellness" model, elevated per-capita spending by 81%, aligning with Pine and Gilmore's (1999) experience economy principles. Digital twin technology improved heritage utilization by 45%, corroborating Latour's actor-network theory in smart tourism systems.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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