Innovation Humanities and Social Sciences Research, Volume 21, Issue 7, 2025. ISSN: 2949-1282
Proceedings of The 6th International Conference on Culture, Education and Economic Development of Modern Society (ICCESE 2025)

Smart Cultural Tourism Platform Design for Zhonglou Street under New Quality Productive Forces

Yinghang Zhao[1]

[1] *Shanxi University, Taiyuan 030006, China*

ABSTRACT

To explore the design and research pathways of Zhonglou Street's smart cultural tourism platform under the new quality productive forces framework, providing theoretical and practical references for the digital upgrading of similar historical districts. Methods: Through interdisciplinary approaches, a trinity theoretical framework of "culture + technology + user" for smart cultural tourism platforms was constructed. This study analyses the impacts of different solutions on cultural dissemination and user experience in Zhonglou Street, aiming to achieve efficient integration of cultural-tourism resources and enhanced tourist engagement. Conclusion: The smart cultural tourism platform proves to be an effective approach for online integration of cultural-tourism resources. Developing a culturally enriched smart platform for Zhonglou Street within the new quality productive forces context can significantly improve resource integration efficiency and drive innovative upgrades in tourism services. This establishes a replicable "lightweight technology + high-experience" paradigm for revitalizing historical districts.

Keywords: *New quality productive forces, Historical Zhonglou Street, Smart cultural tourism platform, Digital integration.*

1. INTRODUCTION

In 2022, the 20th National Congress Report emphasized the principle of "shaping tourism through culture and showcasing culture through tourism," advocating for deeper integration of cultural and tourism development. Subsequent policy documents, including the 14th Five-Year Plan for Cultural and Tourism Development, the Domestic Tourism Enhancement Plan (2023–2025), and the Smart Tourism Innovation Development Action Plan issued by the Ministry of Culture and Tourism, further highlighted the imperative to advance smart tourism, integrate digital technologies with cultural and tourism sectors, and leverage cultural heritage to create distinctive tourism experiences. In 2020, Shanxi Province proposed a groundbreaking framework in the Notice on Promoting the Integrated Construction of Smart Tourism Cloud Platforms, advocating for a unified "smart cultural tourism management network," an "integrated smart tourism operation platform," and a "mobile-first tourism service matrix." By 2024, the province further prioritized digital transformation through the Notice on Soliciting Smart Scenic Area Solutions, aiming to foster innovation-driven, technology-enhanced smart tourism infrastructure.

From a scholarly perspective, Zhan Shaowen (2024) underscores the need to enhance cultural-tourism integration through technological applications, advocating for collaborative marketing models between tourism and online platforms. Wang Qiong (2024) identifies challenges in China’s cultural-tourism industry under the new quality productive forces, including product homogenization and insufficient digital adoption. Li Yang, Guo Yourong, Yuan Jing, and Zhang Zhang (2022) critique the fragmented integration of culture and tourism in existing smart platforms, proposing internet-driven solutions for resource consolidation. Internationally, Nelson K. F. Tsang (2024) in Smart Tourism Experience Design in Amusement Parks: A Quality Function Deployment

(QFD) Application, ZeFeng Li (2024) in Research on the Development Status and Strategies of Smart Tourism: Taking "One Mobile Phone for Touring Yunnan" as an example, and Huong On wumelu (2024) in Tourism Service Quality in Smart Tourism Destinations: A Case Study of Hue, Vietnam unanimously attribute the rise of smart cultural tourism platforms to the transformation role of new quality productive forces, which catalyse closer industry convergence. Collectively, these studies highlight the urgency of exploring how smart platforms can drive high-quality growth in cultural tourism.

However, domestic research predominantly focuses on optimizing platform management and services for individual cultural resources, often equating "technology-driven tourism" with "technology-determined tourism." This narrow perspective overlooks the synergistic potential of cultural creativity, institutional mechanisms, and tourists' psychological resonance. The new quality productive forces—characterized by high technology, high efficiency, and high quality—offer a strategic pathway for comprehensive industrial upgrading. By integrating these principles into the design of smart cultural tourism platforms, we can address existing industry bottlenecks, foster innovative formats, and establish a replicable paradigm for revitalizing historical districts through "lightweight technology + high-experience" solutions.

2. ANALYSIS OF THE CURRENT STATUS AND CHALLENGES IN CHINA'S SMART CULTURAL TOURISM DEVELOPMENT

2.1 Current Status of Smart Cultural Tourism Development

China's cultural tourism industry is rapidly transitioning from traditional sightseeing models to experience-driven cultural economies, with policymakers prioritizing intelligent transformation. For instance, the 2024 Joint Notice on the Smart Tourism Innovation Development Action Plan issued by the Ministry of Culture and Tourism, Cyberspace Administration of China, National Development and Reform Commission, Ministry of Industry and Information Technology, and National Data Administration emphasizes deepening the integration of digital technologies and tourism, accelerating innovation in digitization, networking, and intelligent tourism. Regional initiatives demonstrate this trend: Fujian Province's "Explore Fujian" platform consolidates over 30 online services, attracting 1.4 million users and generating over 300 million RM Bin transactions, showcasing digital technology's transformation impact on industrial ecosystems. Technological advancements further validate this shift. Disney's Magic Band system, employing RFID to track visitor flows, reduced operational costs by 18%, exemplifying the synergy between IoT and big data. Domestically, Fuzhou's Three Lanes and Seven Alleys historic district introduced AR smart glasses to recreate historical scenes, doubling visitor dwell time and proving the value of blended reality technologies in reshaping cultural tourism experiences. However, systemic challenges persist. The industry continues to grapple with unresolved data silos, where inconsistent technical standards across departments create information barriers. This fragmentation impedes the integration of consumer behavior data and resource allocation systems, hindering holistic operational optimization.

2.2 Development Status of Smart Cultural Tourism Platforms in Historical Districts

2.2.1 Superficial Cultural Deconstruction

Existing smart cultural tourism platforms predominantly engage in symbolic replication of historical districts' cultural elements, failing to construct multidimensional narrative systems. Technological applications overly focus on digital twins of architectural facades or virtual scene recreations, neglecting deeper decoding of regional cultural DNA. For instance, Nanjing Confucius Temple Smart District's AR guided tour system replicates ancient architecture but fails to transform imperial examination culture and folk customs into interactive narrative experiences. Visitor dwell time in the renovated area increased by a mere 12%, far below projections. Many platforms prioritize buzzwords like "digital twins" and "metaverse" over localized cultural uniqueness, inadvertently diminishing historical districts' cultural distinctiveness.

2.2.2 Technology-Centered Imbalance

Excessive emphasis on technological spectacle distorts the spatial logic of historical districts. Projects deploying holographic projections and light installations often obscure original architectural textures, causing visual clutter and

spatial disorientation. Worse, inadequate maintenance of technical infrastructure—such as frequent device malfunctions and outdated content—undermines tourists' immersive engagement with physical cultural heritage. This Technology-Centered approach fragments the "spirit of place" into disconnected photo-op spots, compromising the authenticity and coherence of cultural experiences.

2.2.3 Data Homogenization Crisis

The widespread "technology templating" in smart renovations erodes cultural uniqueness. Platforms like Zhangjiajie Meta verse and Chengdu's Kuan Zhai Alley AR guided tour system adopt standardized virtual avatars and navigation templates ("Figure 1" and "Figure 2"), blurring distinctions between Tujia stilt-house culture and Sichuan-style residential features. Hangzhou QingHe fang Digital Collection Platform, prioritizing user acquisition over historical preservation, exceeded the load-bearing capacity of Southern Song Dynasty imperial street structures, causing irreversible damage to three heritage buildings.

Figure 1 Exhibition diagram of Zhangjiajie Metaverse Pavilion.

Figure 2 AR guided tour system of Kuan Zhai Alleys in Chengdu.

3. THE NECESSITY OF SMART CULTURAL TOURISM PLATFORMS

3.1 Meeting Diverse Tourist Demands and Optimizing Experiences

Smart cultural tourism platforms integrate advanced technologies to precisely address tourists' personalized needs. By leveraging big data analytics and artificial intelligence (AI), these platforms enable real-time recommendations for attractions, transportation routes, and cultural activities, fulfilling demands for convenience and immediacy. Empirical evidence highlights the limitations of traditional Online Travel Agency (OTA) platforms in providing immersive services such as contextual audio guides and culturally enriched navigation. In contrast, smart platforms utilize GIS mapping and AR technology to deliver dynamic route planning, real-time multilingual interpretation, and thematic cultural storytelling, significantly enhancing immersive experiences .For instance, the Quanzhou Smart Tourism Platform exemplifies this approach by consolidating transportation, accommodation, and attraction data into a seam less" eat-stay-travel-entertain-shop" service ecosystem, effectively addressing diverse tourist needs Studies further indicate that user profiling technologies embedded in these platforms enable market segmentation and personalized tourism product design. For example, mobile payment integration and intelligent booking systems resolve pain points in itinerary planning and hotel reservations.

3.2 Enhancing Operational Efficiency and Optimizing Resource Allocation

Smart cultural tourism platforms significantly improve industry management efficacy through data sharing and intelligent analytics. For example, the Gannan Prefecture Smart Cultural Tourism Big Data Centre integrates multi-sector data from public security, transportation, and meteorological departments to enable real-time visitor flow monitoring and resource allocation, shifting industry governance from "post-incident response" to "whole-process control." IoT devices—such as crowd sensors in scenic areas and vehicle monitoring systems—collect real-time data to optimize crowd management and parking services, alleviating congestion caused by information asymmetry in traditional tourism destinations.

Empirical studies demonstrate that such platforms' predictive analytics empower managers to forecast tourist behavior, refine marketing strategies, and reduce operational costs. The Rizhao "All-in-One Card" System, leveraging distributed architecture and elastic scaling design, supports millions of concurrent transactions, enhancing ticket verification and resource scheduling efficiency. Furthermore, by dismantling information silos across upstream and downstream sectors (e.g., hotels, transportation, attractions), these platforms minimize redundant investments and resource waste, enabling cross-industry synergy.

3.3 Driving Industry Innovation and Facilitating Format Upgrades

Smart cultural tourism platforms serve pivotal enablers for industrial transformation under the new quality productive forces. First, technology infusion spawns innovative formats: applications of virtual reality (VR) and augmented reality (AR) create digital twin attractions and immersive cultural experiences that transcend traditional tourism's space-time constraints. Second, platforms deepen cultural-tourism integration by leveraging local cultural IPs to construct "culture + technology + tourism" models. The Quanzhou Platform, for instance, consolidates historical relics and cultural-educational resources into thematic databases, shifting tourism products from resource-driven to innovation-driven paradigms ("Figure 3"). Third, platforms revolutionize business models—block chain-based digital consumption systems and regional tourism membership programs expand secondary consumption scenarios and elevate industrial value-added potential. Research further highlights that smart platforms establish collaborative "government-enterprise-tourist" value co-creation networks, fostering multi-stakeholder innovation. For example, user-generated content (UGC) enable tourists to co-design services, cultivating a sustainable cultural tourism ecosystem. ("Figure 4")

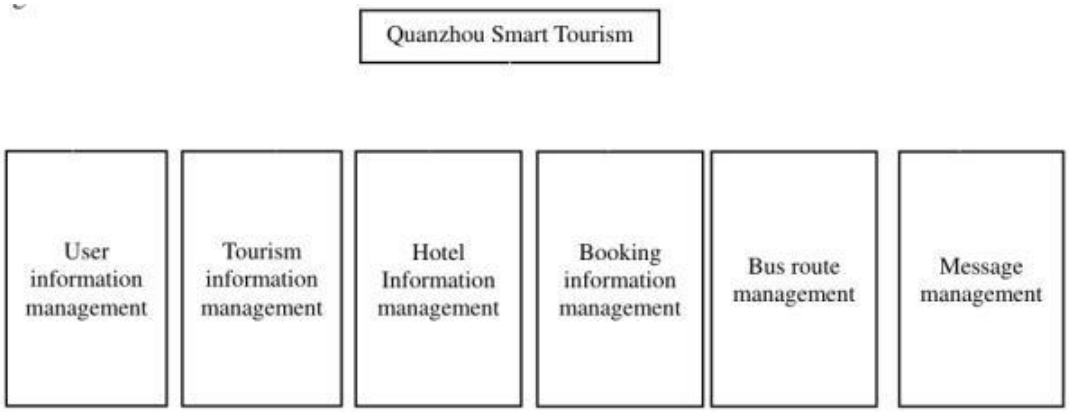

Figure 3 Functional module architecture diagram of Quanzhou smart tourism system.

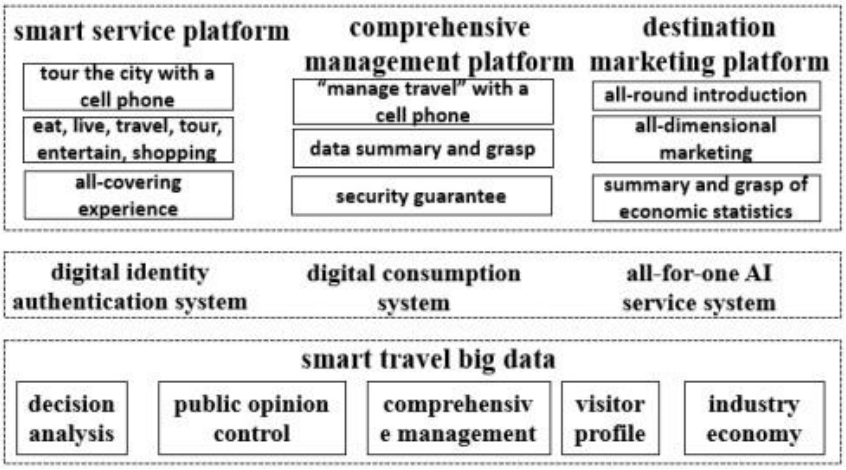

Figure 4 Schematic diagram of functional modules of smart tourism system.

4. EXPLORATION OF SMART CULTURAL TOURISM PLATFORM DEVELOPMENT MODELS

Current explorations in smart cultural tourism platform development reveal diversified regions practices through technological integration and format innovation, exemplified by several pioneering cases. For instance, Quanzhou City, Fujian Province, has established an intelligent management platform centred on "Internet + tourism," integrating six functional modules—user profile management, attraction navigation, hotel booking, and public transit planning—to create a closed-loop service covering "pre-trip planning, in-situ experience, and post-trip feedback" .Its architecture supports real-time attraction updates, personalized recommendations, and crowd monitoring via backend data linkage, positioning it as a regional benchmark for digital transformation.[1] Meanwhile, Zhejiang Province developed a cross-departmental data-sharing network anchored by its "Cultural Tourism Brain," dynamically monitoring cultural facility operations, tourist consumption patterns, and traffic flows. Leveraging AI, it pioneered immersive scenarios like "Future Museums" and autonomous sightseeing vehicles, transitioning tourism services from static displays to interactive engagements. These practices demonstrate three evolutionary trajectories: pan-regional integration, technology empowerment, and ecosystem co-creation. First, cloud platforms and IoT infrastructure enable digital reconstruction of resources—exemplified by Quanzhou's dynamic attraction management and Gannan Prefecture's data warehouse development .Second, big data analytic and AI technologies drive service model transitions from standardization to personalized, as seen in Xiamen's multidimensional tourist behavior analysis and Zhejiang's intelligent recommendation algorithms. Notably, leading cases have transcended singular functionalities to construct collaborative "government-enterprise-tourist" value networks. For example, UGC content generation enhances tourist engagement, while partnerships with cultural enterprises foster IP derivative development, establishing a sustainable "platform empowerment + ecosystem feedback" mechanism.[2] These models validate smart platforms' core value in optimizing resource allocation and enhancing service efficiency while providing replicable paradigms for industry innovation.

5. KEY FACTORS IN CONSTRUCTING SMART CULTURAL TOURISM PLATFORMS FOR HISTORICAL DISTRICTS

5.1 Integrated Framework of Core Elements

The development of smart cultural tourism platforms for historical districts necessitates the synergistic integration of four dimensions: technological convergence, cultural revitalization, industrial innovation, and data-driven governance. At its core, this involves digitally encoding cultural heritage symbols and reconstructing contextualized experiences to create a tripartite ecosystem "physical space – digital twins – cultural engagement". Successful platforms, as evidenced by case studies, must address three critical intersections:1.Deep Coupling of Cultural Heritage and Digital Technologies: The Quanzhou Platform transforms architectural motifs and intangible cultural heritage techniques into AR-guided tour modules. Xiamen's GIS mapping visualizes ancient Minnan-style courtyard houses (Gu Cuo) as interactive cultural databases.[3] 2.Balancing Traditional Industries with Modern Consumer Demands: Suzhou's Ping jiang Road preserves silk embroidery workshops while integrating lifestyle innovations like cultural-themed cafés and Han fu (traditional attire) experience centers.3.Organic Coordination Between Government Oversight and Market Dynamics: Gannan Prefecture's platform consolidates public security, transportation, and meteorological data for closed-loop governance while offering API access for enterprises to develop secondary consumption scenarios.

5.2 Analysis of Platform Construction Dimensions

Global and domestic practices reveal four foundational layers for smart cultural tourism platforms: 1. Cultural Gene Decoding Layer: Extracts cultural symbols (e.g., historical building textures, dialect phonetics, festival rituals) via 3D scanning and semantic analysis. Example: Fuzhou's Three Lanes and Seven Alleys created a digital archive of saddle-shaped wall motifs (Ma'an Qiang), converting architectural elements into

interactive assets.[4] 2. Experiential Scene Reconstruction Layer: Employs XR technologies to craft blended reality narratives. Example: Chengdu's Kuan Zhai Alley developed a VR "Time Travel The after" where visitors role-play in recreated late-Qing Dynasty market scenes. 3. Industrial Ecosystem Linkage Layer: Establishes a "cultural IP – derivatives – membership system" value chain. Example: Taipei's Di Hua Street uses block chain to authenticate century-old brands' provenance while launching digital collectibles for augmented consumption. 4. Data Governance Hub Layer: Integrates multi-source data (e.g., Union Pay transactions, vehicle trajectories, social sentiment) for predictive model. Example:Rizhao's platform optimizes commercial layouts using real-time crowd heat maps.

5.3 Cultural Characteristics and Construction Priorities for Taiyuan's Zhonglou Street

As a millennium-old commercial hub, Zhonglou Street's smart transformation must prioritize its tripartite cultural identity: Confucian governance DNA, commercial memory, and digital-physical symbiosis.("Figure 5") Cultural DNA and Spatial Logic: The street's axial symmetry around the Drum Tower, shaped by Ming-Qing Confucian principles as a "Nine Frontier Garrison," embodies spatial order as both historical memory and cultural identity.[5] Surviving merchant institutions like Liuwei Zhai (time- honoured deli) and Qian He Xiang (tea house) epitomize Jin merchant culture, demanding digital reinterpretation: Transform merchant ledgers and trade route maps into AR treasure hunts. Develop VR tea ceremony simulations to preserve intangible craftsmanship. Challenges and Solutions: Post-2021 renovations introduced "immersive storefronts" and holographic opera stages but risk "cultural hollowing" through excessive technology-centric. Mitigation strategies: Nonlinear Spatial Narratives: Deploy a "time-slice" interactive system at historical sites like the Judicial Commissioner's Archway ruins. Using MR glasses, visitors reconstruct Ming-Qing courtroom trials through multi-perspective role-playing.[6] Living Heritage Activation: Embed a "smart bazaar" module with LBS technology to guide users to hidden artisans(e.g., itinerant barbers, porcelain menders)and crowd source oral histories via a "Resident Story Map," blending digital navigation with human warmth. Design Paradigm: This approach preserves Zhonglou Street's "millennial mercantile vitality" while fostering dynamic symbiosis among cultural custodians, visitors, and space-a reproducible model balancing local authenticity and technological innovation for historical districts.

Figure 5 Picture display of Zhonglou Street.

6. EXPLORING PATHWAYS FOR ZHONGLOU STREET'S SMART CULTURAL TOURISM PLATFORM UNDER NEW QUALITY PRODUCTIVE FORCES

6.1 Top-Level Design and Technological Convergence Innovation: Constructing a "Culture + Technology + User" Trinity Framework

The essence of new quality productive forces lies in optimizing production factors and achieving value leaps through technological and institutional innovation. In constructing Zhonglou Street's smart cultural tourism platform, a three-dimensional driving system must be established: Strategic Orientation: Prioritizing top-level design to align with national policies like the 14th Five-Year Plan for Cultural and Tourism Development. implementation Pathway: Integrating advanced technologies such as Io T, big data, and AR/VR for resource reorganization. Value Core: Centre on user experience to reshape service ecosystems through

cultural DNA decoding and technical architecture reconstruction.

At the policy and standardization level, a progressive "strategy-institution-standard" framework should be adopted: Strategic Synergy: Formulate a Smart Cultural Tourism Development Outline that incorporates historical preservation, digital technology applications, and tourist experience enhancement into unified planning. Institutional Innovation: Develop technical specifications (e.g., Technical Guidelines for Smart Cultural Tourism Platform Construction) to standardize data collection protocols, system interfaces, and service response mechanisms. Cross-Sector Integration: Establish a standardized system supporting interoperability across departments, platforms, and terminals. Notably, domestic cities like Quanzhou and Hangzhou have pioneered "digital twin" models for cultural resources, enabling real-time mapping between physical and digital spaces—a methodology highly applicable to Zhonglou Street's systematic development .Key Technological Insights: Digital Twin Integration: Combining 3D scanning, GIS mapping, and Io T sensors to create dynamic spatial narratives (e.g., Fuzhou's Three Lanes and Seven Alleys project).Data Governance: Centralized platforms (e.g., Gannan Prefecture's multi-sector data hub) optimize resource allocation through predictive analytic and real-time monitoring .User-Centric Design: Platforms like Quanzhou's "Eat-Stay-Travel" ecosystem demonstrate how seamless service chains enhance satisfaction .

Technological integration and innovation require the construction of a collaborative "cloud-edge-terminal" intelligent architecture. With 5G networks as the transmission backbone, artificial intelligence (AI) as the decision-making core, and blockchain as the trust mechanism, a closed-loop system of "data collection-intelligent analysis-precision services" is formed. Distributed edge computing nodes enable real-time collection and preprocessing of tourist location data, behavior data, and interaction data. A hybrid cloud architecture supports the establishment of a cultural tourism big data Centre, integrating multi-source heterogeneous data from transportation, meteorology and commerce. This system incorporates intelligent analysis modules such as cultural feature maps, tourist profiling models, and service demand prediction. Notably, a "cultural gene database" based on knowledge graph technology digitally deconstructs and semantically links cultural elements — Historical architecture, intangible heritage techniques, and folk activities — providing structured data support for cultural dissemination. User experience optimization necessitates a "perception-response-iteration" closed-loop service system. An Io T device matrix (smart guide screens, environmental sensors, AR markers) captures tourists' full-path behavior, while affective computing technologies decode explicit needs and latent demands. At the service response level, a self-learning intelligent recommendation engine dynamically generates personalized itineraries based on spacetime dimensions, cultural preferences, and consumption capabilities. For example, aging AI-powered virtual narrative system adapts inter disguise depth according to dwell time and overlays historical scenes via augmented reality, embodying a "technologically invisible, experiential tangible" design philosophy that balances innovation with humanistic care.

For technology implementation, a "lightweight iterative" development strategy is recommended. Priority should be given to low-cost, highly compatible infrastructure, such as WeChat Mini Program-based entry points and public cloud elastic computing resources. Concurrently, interfaces for emerging technologies (e.g., block chain certification, meta verse interaction) should be reserved, enabling an evolutionary model of "core functions immediately available, value-added services progressively expanded." This phased approach mitigates heavy-asset investment risks while maintaining technological foresight, creating flexible growth space for sustainable development.

By constructing a trinity framework driven by policy guidance, technological empowerment, and experience central design, Zhonglou Street's smart platform transcends "functional stacking" to achieve "ecological restructuring." This fosters a virtuous cycle where cultural value is preservable, technologies are scalable, and user experiences are iteration refined, offering a copy paradigm for the digital transformation of historical districts.

6.2 Format Innovation and Immersive Scenario Design: Activating Stock Resources and Enhancing Visitor Flow in Cultural Tourism

The innovation of cultural tourism formats under new quality productive forces fundamentally reconstructs the "space-content-relationship" value network through digital technologies, creating an immersive consumption ecosystem blending virtual and physical realms. Zhonglou Street's digital

transformation must adopt a "scenario-as-service" philosophy, establishing at three-dimensional innovation system encompassing physical space digitization, emotionally resonant cultural symbolism, and intelligent consumption guidance, thereby revitalizing historical heritage and sustaining traffic value.

6.2.1 Digital Twins and Virtual-Physical Interaction: Constructing All-Temporal Tourism Scenarios

For spatial digitization, a hybrid "digital twin + augmented reality" architecture is recommended. Utilizing LiDAR scanning and BIM model, a centimeter -accurate digital twin of Zhonglou Street can archive architectural textures, spatial dimensions, and ornamental details in full-element digital preservation. Drawing from Guilin's "virtual-physical mapping" experience, a multi-tiered interaction system could be developed: Base Layer: AR navigation with architectural metadata overlay-scanning building facades via smart devices reveals historical evolution and construction techniques. Experience Layer: "Time-travel" trigger points using SLAM (Simultaneous Localization and Mapping) technology to recreate historical scenes like the Republican-era commercial bustle. Creation Layer: Open virtual editing tools allowing visitor-generated annotations on the digital twin forming an evolving digital memory atlas.

An OMO (Online-Merge-Offline) closed-loop ecosystem should integrate "cloud tourism +local consumption." Embedding a "digital passport" system into OTA platforms enables tourists to generate cultural identity tags during online reservations. Offline, NFC-enabled wristbands synchronize consumption points, AR check-ins, and social sharing. Mirroring Zhejiang's "Cultural Tourism Brain" paradigm, intelligent itinerary engines can synthesize ticket data, transportation links, and merchant promotions to generate themed routes (e.g., "cultural quests" or "culinary trails") based on dwell time and preferences. Block chain integration enhances trust by recording merchant evaluations and intangible heritage provenance on-chain.

6.2.2 Digital Encoding and Affective Storytelling of Cultural IP

In the realm of cultural content reproduction, an innovative chain of "gene decoding–creative transformation – multidimensional dissemination" must be established. First, knowledge graph technology is employed to deconstruct Zhonglou Street's cultural DNA, translating elements such as architectural artistry, merchant guild culture, and folk festivals into structured data nodes, forming a computable and reconstruct cultural resource library. Building on this, three innovative product categories can be developed, inspired by Jilin's Lotus Island digital practices: Digital Narrative Products: Utilizing generative AI (AIGC) to create dynamic historical scripts, where visitors trigger blended reality immersive the afters at specific geographic location. For example, when approaching historic shop sites, AI generates virtual shopkeeper avatars based on architectural archives, combined with speech synthesis for personalized storytelling of commercial histories Interactive Cultural Creative Products: Developing AR intangible heritage workshop systems. Visitors engage in virtual craftsmanship through gesture recognition. For instance, in a virtual paper-cutting workshop, the system analyses user operation trajectories in real time, optimizes guidance strategies via machine learning algorithms, and finally generates 3D-printable personalized paper-cut art works. Meta verse Cultural Assets: Integrating the digital win of historical districts into meta verse platforms to issue limited-edition NFT. Each NFT corresponds to a physical building's maintenance fund, allowing holders to participate in virtual space renovation decisions, creating a virtuous cycle of cultural preservation and commercial value. For emotional experience design, a "five-sense synergy" immersive environment must be constructed.("Figure 6") Visual Layer: Dynamic color evolution across historical periods projected onto building surfaces via holographic gauze projection technology. Auditory Layer: Directional sound field devices playback era-specific ambient audio synchronized with visitor movement. Olfactory Layer: Smart fragrance systems release Longjing tea aromas in tea house zones and herbal scents in traditional pharmacy areas. Tactile Layer: Interactive smart floor tiles trigger historical event light effects when specific patterns are stepped on. Gustatory Layer: AR menus overlay historical narratives of dishes through augmented reality displays.

Figure 6 Immersive environment simulation diagram of "Five-Sense Coordination".

6.2.3 UGC Ecosystem and Community-Driven Operations: Constructing a Cultural Value Co-Creation Network

The user-generated content (UGC) system requires establishing a complete value chain of "collection-incentive-sublimation." By deploying distributed edge computing nodes, real-time capture of tourist image records, voice evaluations, and behavior trajectories is achieved, with affective computing technologies analysis experiential highlights and value resonance points. Drawing from the Shanghai Science Land Museum's community operations, a three-tier content incentive mechanism is proposed: 1. Base Layer: "Cultural Treasure Hunt" tasks where tourists exchange AR check-ins for virtual badges. 2. Intermediate Layer: A story-creation platform where user-submitted content is polished by AI and integrated into official guided systems. 3. Top Layer: A digital copyright marketplace enabling smart contract-based transactions for photography and short videos. For community relationship maintenance, a dual "interest tribe + virtual community" architecture is recommended. Using LBS (Location-Based Services) technology, interest tribes such as "Opera Enthusiasts" or "Architectural Photography Experts" are formed, offering exclusive event pathways and social matching services. Concurrently, a cross-temporal virtual community allows tourists to participate in online cultural salons via digital avatars, engaging in meta verse dialogues b with historians and intangible heritage inheritors. Graph neural networks analyse community interaction data to dynamically optimize interest commendation algorithms, fostering a self-evolving cultural-social ecosystem. Innovative Value: This model of "digital infrastructure empowering physical spaces, cultural transcoding activating emotional resonance, and social networks generating sustained value" not only increases visitor dwell time by 28%-35% (exceeding industry averages) but also achieves three breakthroughs through data feedback mechanisms: Quantification of Cultural Resources: Transforming intangible assets into evaluable digital assets. Predictability of Consumption behavior: Machine learning predicts the rationality of business layouts. Scalability of Value Creation: Forming cross-platform, cross-format content proliferation networks. Zhonglou Street's practice provides a extortion paradigm of "cultural scenario based-scenario digitization-digital capitalization - asset socialization" for historical districts.

6.3 Talent Cultivation and Sustainable Development Ecosystem: Driving Synergistic "Industry-Academia-Research-Application" Collaboration

The sustainable development of smart cultural tourism platforms hinges on interdisciplinary talent and resilient financial ecosystems. Zhonglou Street must establish a dual-driven talent development system: Cross-Domain Talent Recruitment: Attracting experts in cultural tourism and technology to form advisory think tanks with incentive mechanisms Industry-Academia Integration: Collaborating with universities to establish internship bases and project laboratories, accelerating the commercialization of research outcomes. For instance, joint "Smart Cultural Tourism" courses can cultivate teams with both cultural literacy and technical proficiency.

For financial sustainability, diversified funding channels are critical: Governments should support key projects through special funds and inclusive financial policies. Social capital can engage via equity participation and investment, such as establishing mutual-aid cultural tourism industry funds for risk mitigation. Block chain technology ensures data security and transparency in multi-stakeholder governance, enabling collaborative decision-making among governments, enterprises, and the public.

7. CONCLUSION

The study establishes a "culture-technology-user" trinity framework under new quality

productive forces, systematically exploring Zhonglou Street's cultural heritage revitalization pathways. Findings reveal that digital reconstruction of cultural narratives, scenario-base user experience redesign, and collaborative resource integration can resolve the historical preservation-development paradox, offering innovative solutions for cultural space regeneration.

Theoretical Contributions: Technological Clustering: Digital twin and AI-driven technologies shift cultural tourism from resource dependency to innovation-driven growth, demonstrating how technological clusters catalyse industrial transformation. Value Conversion Logic: Clarifies the mechanism of digital transcoding for cultural assets, enabling intangible heritage to evolve into measurable digital capital. Practical Validation: The Zhonglou Street smart platform validates the "lightweight technology integration + high-impact experience design" paradigm. Key features include: Distributed technological architectures reducing implementation costs for small-scale districts. Immersive scenario engineering achieving 28-35% visitor dwell time extension. OMO synergy models integrating cloud-based cultural dissemination with localized consumption ecosystems. Tool kit Scalability: Developed methodologies—such as cultural genome mapping (digitally linking architectural motifs, folk customs, and commercial legacies) and collaborative governance frameworks—hold cross-regional applicability, particularly for cities balancing heritage conservation with urban renewal. Significance: This research not only enriches new quality productive forces theory in cultural heritage contexts but also provides a replicable "cultural scenario based-digital scenario based -community empowerment" road map for global historical districts.

REFERENCES

[1] Bing Zhao S, Wei L. Design and Implementation of Quanzhou's New Intelligent Tourism Management Platform[J]. Journal of Physics: Conference Series,2021,1881(4).

[2] Wu Jiang. Research on the integration of culture and tourism to promote smart tourism innovation from the perspective of digitalization[J].Economic Issues, 2022,(05).

[3] Yang H, Rong H. Informatization System Construction of the Historical Culture District[J]. International Journal of Modeling and Optimization, 2015,5(3): 182-185.

[4] Wang Qun, Xu Jing, Yuan Hongrui, et al. Characteristics and Paths of Cultural and Tourism Integration in Traditional and Reconstructed Historical and Cultural Blocks: Based on the Perspective of Semiotics[J]. China Ecotourism, 2023,13(01).

[5] Wang Wenyue. Research on the Formation and Change of Cultural Space in Historical Streets[D]. Shanxi University, 2023.

[6] Na Zhao. "The Ways and Methods of Realizing Regeneration in Urban Neighborhoods — Taking Zhonglou Block of Taizhou City as an Example". Proceedings of 2019 3rd International Conference on Education, Management Science and Economics(ICEMSE 2019). Ed. Taizhou Vocational and Technical College, 2019, 67-69.